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# GEOLOGY

AND

# MINERAL RESOURCES

OF THE

# JAMES RIVER VALLEY

VIRGINIA, U. S. A.

*WITH MAP AND GEOLOGICAL SECTIONS*

BY

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# GEOLOGY AND MINERAL RESOURCES

OF THE

# JAMES RIVER VALLEY.

It has been my privilege recently to complete a professional survey of the mineral resources of the James River valley in Virginia, and to examine with some care the facilities available for developing their value.

Investigations in this field have been in progress for several years, with reference to the general geology and the special resources of the State of Virginia; while papers on special points have been published from time to time by other observers. So far as these throw light upon the general subject, I have made free use of them—giving due credit to their authors.

During the past summer, aided by my assistant, Mr. H. D. Campbell, I explored portions of the territory along the river valley that had not been previously examined, and the points formerly investigated were then reviewed to ascertain what new developments had been made.

My object now is to lay before the minds of capitalists, immigrants, our own citizens, and others who are interested in Virginia, a concise yet comprehensive statement of the great extent and variety of available resources within the area under review, which only await capital, enterprise, and labor to make them productive. The time has come when the facilities for intercommunication and for rapid and cheap transportation along the valley of the James must bring in capital and develop new enterprises, until this region shall become second to no other portion of the State of Virginia, and shall rank with the other leading industrial belts of the country.

While the scientist will appreciate the representation given of the peculiar topography of this valley, and of the numerous geological formations exposed therein with their great treasures of mineral wealth, the economist and practical worker will, moreover, recognize the great advantages now afforded by the opening of a line of railway—the Richmond and Alleghany—which traverses the whole length of the river valley. At Richmond it reaches a great manufacturing centre, strikes tide-water, and finds railway connections north and south. Lynchburg, another manufacturing city, is also a point of railway connections, north-east to Washington City, south-east to Norfolk (an important seaport), and south-west by unbroken lines to the Mississippi.

At Lexington the Baltimore and Ohio system links the valley of the James with the coal and coke region about Connellsville, Pa., and the myriads of industries of Pittsburg. At Buchanan another line to the south-west and a road to the New River coal-fields of West Virginia will be furnished by the Shenandoah Valley system, while from the junction at Clifton Forge the Chesapeake and Ohio leads to the coal and coke supplies of the Kanawha valley, and reaches, directly or indirectly, all the great business centres of the North-west. It is, moreover, contemplated that the Richmond and Alleghany with the Ohio Central will ultimately, by their extensions and by bridging the Ohio River at Point Pleasant, give a continuous line from Richmond, Va., to Toledo, Ohio, and thus connect with the entire system of north-western railways.

Feeling confident of engaging the attention of both scientific explorers and practical economists, I now proceed to give a general view of the topography and the geology of the valleys of the James and its tributaries, and to enumerate the valuable resources to be found there.

Topography.—The accompanying map should be frequently consulted, as we advance with this part of our subject. The Richmond and Alleghany Railway, ascending the valley of the James along the north bank of the river to Bremo, a distance of 60 miles, there connects by a bridge with a branch railroad now under construction in Buckingham County. The iron-ores, gold, and forests of this county will presently engage our especial attention.

As the main line of road approaches the southwest trend of outliers of the Blue Ridge range, locally known as "Buffalo Ridge," ample indications appear of superior iron-ores, already known to commerce for use in the Bessemer process. Their localities are indicated upon the map, and will be stated in detail farther on in our discussion.

At Joshua Falls, 134 miles west of Richmond, the railway crosses the James, and continues on or near the iron tract to Lynchburg. For 28 miles above that city the river has cut through successive ranges of mountains, and thus opened for the road a route of uniform and easy grades.

At Balcony Falls the river and railway pass through the Blue Ridge by a cañon more than a thousand feet deep, on each side of which a natural section of the mountain range is displayed, thus affording an interesting field of study for the geologist, and wild scenery that commands the admiration of every traveller who appreciates a combination of the grand and beautiful in nature.

The North River enters the James at this point, and along its eastern bank runs the branch road that leads to Lexington, the resting-place of Lee and (Stonewall) Jackson, and the seat of Washington and Lee University and the Virginia Military Institute, both of which have long been among the leading educational institutions of the South.

The main line, continuing its westward course, passes within two miles of the famous Natural Bridge, from which the county of Rockbridge takes its name.

This great natural curiosity, although wonderful in itself, and at the same time intimately associated with traditions of Washington and Jefferson, and with interesting events in the early history of Virginia, has been much neglected for want of convenient transportation; but now, with easy access by rail and with enlarged and improved accommodations for visitors, it will soon command its merited attention, as ranking among the great wonders of the world.

The Shenandoah Valley road crosses both arms of the Richmond and Alleghany, the one about half way between Lexington and the mouth of the North River, and the other a few miles above Balcony Falls on the James.

Craig's Creek Valley, in Botetourt and Craig counties, is another lateral field, abounding in iron ores and timber, that can be fully utilized only by being brought within reach of some leading railroad line. The valley of Potts Creek, in Alleghany County, is another inviting route for either a feeder or a through line to New River.

The line of the Richmond and Alleghany Railroad has the advantage of its grades all descending gently in the direction of the heaviest traffic. Its topographical surroundings are such that the minerals (which will be presently discussed in detail) can, as a rule, be conveyed to the railroad by descending grades along the lateral valleys traversed by the affluents of the two main rivers. The transportation of agricultural and other products has similar advantages.

The peculiar and varied topography of the country all along both branches of the line from Richmond either to Lexington or Clifton Forge gives an extent and variety of picturesque scenery that, in itself alone, richly rewards the traveller for a journey over this road.

Geological Features.—Mineral resources and geological peculiarities are so intimately related that the former cannot be fully comprehended, certainly not adequately appreciated, without some general knowledge of the latter. This is eminently true of a region so extensive and so diversified as that which is the subject of this paper. Iron-ore beds and ledges of limestone are found contiguous to each other, and at the same time conspicuous in five of the great geological formations cut by the valley of the James.

In one of these five are gold-mines and quarries of granite and slate, with other less important minerals.

In a sixth but more recent formation occur the coal-mines of Henrico, Chesterfield, Goochland, and Powhatan counties; and extended observations along the proposed line of the road through West Virginia would include the geology and resources of the Appalachian coal-field.

Before entering upon a detailed account of their mineral wealth, it will be proper to enumerate the several geological formations in the order of their ages, beginning with the oldest; and to mention some of the leading peculiarities by which each is characterized, and the localities in which it may be found. The nomenclature and notation used correspond, as nearly as may be, with those employed by Prof. Rogers in Macfarlane's Geological Ry. Guide, while the numbers given in his Virginia Reports will be put in parentheses, as (VII.), (X. *a*), etc.

I. THE ARCHÆAN OR EOZOIC AGE.—1 *a*, *b*, *c* includes numerous and extensive beds of granite, gneiss, mica-slates, talc-slates, chlorite-slates, sandstones, crystallized limestones, and other minerals, all of which have been greatly affected by heat and other agencies, and are hence called "metamorphic rocks." In the river and along its banks at Richmond, and for some miles above the city, some of these ancient rocks are represented in conspicuous beds of gneiss and gneissoid granite. Rocks of Eozoic age crop out over the greater part of Middle and Piedmont Virginia. In these no traces of fossil remains, whether of plant or animal, have been found. They antedate by millenniums the oldest flora and fauna that left any marks of organic life on this part of our globe. But poor as they are in the relics of life, they are rich in minerals of various kinds. (See Geological Section No. I., page 39.)

II. THE PRIMORDIAL OR LOWER CAMBRIAN AGE.—2 *a*, *b* (I. R.). The rocks of this age are chiefly sandstones and shales, and form the numerous broken ridges that skirt the north-western slope of the Blue Ridge range. They present a fine section of their strata in the gorge of the river at Balcony Falls. The upper shales of this formation abound in iron ores. (See Section No. II., p. 51.)

III. THE MIDDLE CAMBRIAN.—3 *a*, *b*, *c* (II. R.). This is the Canadian Period of the Lower Silurian, and is characterized by heavy beds of limestones, among the lower and older of which, especially that from which the hydraulic limestone is obtained, numerous beds of shale are interstratified. Rocks of this period may be seen cropping out in most of the cuts on the railroad between Greenlee's Ferry and Eagle Rock, and in extensive exposures along the North River branch, nearly as far as Lexington. The same strata of limestone form the abutments and arch of the Natural Bridge.

IV. THE UPPER CAMBRIAN.—4 *a*, *b*, *c* (III. R.). This, the "Trenton Period" of Dana, in Rockbridge and Botetourt counties, has for its base a heavy bed of gray coraline limestone, highly valued for fluxing, for the manufacture of lime, and for building-stone. Exposures of its middle and higher strata occur near Eagle Rock, in Botetourt, and are very extensive in the neighborhood of Lexington. This is the formation upon which the town stands.

V. UPPER SILURIAN.—5 *a*, *b*, *c*, 6, 7, and 8 (IV., V., VI., VII. R.). The lower portion of this group of formations consists of several beds of sandstone of varying thickness, separated from one another by shales that are the repositories of valuable iron ores. The beautiful arch above Iron Gate, at Clifton Forge, is the finest representation of these rocks anywhere along this route. (See Section VI. p. 64.) They are more ruggedly but not so strikingly displayed at Eagle Rock. No. 6 (Niagara) is only doubtfully represented in this part of Virginia.

No. 7 (VI. R.) is the Lower Helderberg limestone, well displayed at Price's Bluff, and in both abutments of the arch at Clifton Forge. Immediately overlying this (geologically) is No. 8 (VII. R.) —the Oriskany formation—composed very largely of a coarse gray and brown sandstone, but carrying with it the heaviest beds of limonite ores found in this region of the State. (Refer to Sections Nos. V., VI., and VII., pp. 58, 64, and 65.)

VI. Devonian.—10 *a*, *b*, *c* (VIII. R.). This is the formation so largely represented in the slaty hills between Eagle Rock and Iron Gate, and between Clifton Forge and the White Sulphur Springs.

The great *Carboniferous* group (X. to XVI. R.) is beyond our present line of discussion, but has an important bearing on it as the great source of fuel.

The Richmond coal-field is of more recent date than that of West Virginia, and belongs to the Mesozoic Age. Higher up in the series are the Tertiary beds on which the city of Richmond stands.

From these brief statements it will be seen that the geology of this railroad line, when extended to the Ohio River, will represent all the leading features of the geology of Virginia.

## MINERAL RESOURCES OF THESE SEVERAL GEOLOGICAL FORMATIONS.

The position and extent of these will be more clearly understood from what follows.

1st. The stratified rocks of the region under review were originally deposited by the action of water, and left in a horizontal position; but they have been subsequently arched and folded, tilted and fractured, then eroded by running water, or by water and ice together, until among the metamorphic rocks east of the Blue Ridge, and in the limestones of the Great Valley, we rarely see anything but their upturned edges. At a few points, however, we find the arches preserved, as for example in the cliffs opposite Lynchburg and at Clifton Forge.

2d. The lines of foldings and the outcropping edges of broken strata throughout the State have a bearing (strike) nearly north-east and south-west—

nearly parallel with the general trend of the Blue Ridge.

3d. Whatever may have been the causes that produced the upturning, bending, and breaking of the stratified rocks on so grand a scale, the results are now of the highest importance. Mineral deposits, that might otherwise have been forever concealed, have been brought distinctly to view by geological agencies. Mining, which would have been difficult and expensive in deeply buried strata, has been made easy by their upheaval to the surface.

## VARIETIES OF IRON-ORES.

Of all the varieties of ores employed in the manufacture of iron, only one is wanting on the line of the R. & A. R. R., and even this one will be reached by the future extension of the road into the coal regions. These are:

(*a*) *Magnetite* or magnetic ore—so called because it is attracted by the magnet. When there are points in a lump of it that sometimes attract and sometimes repel the magnetic needle, such a mass is a lodestone. Besides this property of attraction, it retains its dark color when ground to a fine powder, which is iron-black when the ore is pure. The purest magnetite consists of 72.4 per centum of metal and 27.6 of oxygen. Titanium is often found in this ore, and when abundant damages the quality of the iron.

(*b*) *Specular Ore* is so called from the brilliant lustre of its crystalline forms. It is also called Red Hæmatite, from the blood-red color of its fine powder, as seen when rubbed or scratched by any hard body, as a file. Its purest form consists of 70 per cent of metallic iron and 30 of oxygen. A fragment of it becomes magnetic when heated on charcoal by the blowpipe. This and the magnetite are the most important of the ores found in the metamorphic rocks of eastern Virginia. They are sometimes called the "steel ores."

(*c*) *Limonite* (Brown Hæmatite) occurs sometimes in masses that are porous or cellular in structure and of a dark brown color; sometimes granular or earthy, and mixed with clay, so as to require washing before it is fit for the furnace. When heated in a glass tube it gives off water that soon lines the cooler parts of the tube. When pure its composition is: metallic iron, 60; oxygen, 25.6; and water, 14.4 per cent.

(*d*) *Spathic Ore* (carbonate of iron) is found in the coal regions of West Virginia among the coal-bearing rocks as Black Band ore and clay-iron-stone. In its purest form it can never contain over 49 per cent of metallic iron.

The Buckingham Field.—In this the *limonite ores* have been found in three nearly parallel beds, or leads, extending from the neighborhood of New Canton, on the river, towards Buckingham Court House, for a distance not yet determined. They are designated on the map as L. Nos. 1, 2, and 3, beginning with the ore farthest east. L. No. 1 was opened many years ago near the old Dean Furnace at New Canton, and ore seems to have been mined from it at several points to supply that furnace. It evidently has good ore in it, but a large proportion of the ore is very silicious, and some of it is quite shaly. The good ore could, however, be assorted out in mining. The bed is from six to seven feet thick. Its walls are hard silicious and micaceous slates. L. No. 2 was opened at Bremo on the Fluvanna side of the river, and worked under authority of the Confederate Government during the civil war. The lead is there three and a half feet thick. It has been traced in a northeast direction for three or four miles into Fluvanna County, and opened on the lands of Mr. W. G. Melton and Mr. Dennis. It crosses the river at the ferry, where it has been worked to some extent on the Buckingham side, and the thickness has there increased to six feet. After passing beneath the village of New Canton, it has been traced for some miles toward the south-west; and some openings have been made in it from which good ore has been mined. At one of these, about one and a half miles from the village, the thickness is fully twelve feet. From this bed the Dean Furnace was in part supplied with ore, which is reported to have made excellent iron. This lead is also imbedded in hard silicious and micaceous slates, and is nearly vertical in position. The distance between Nos. 1 and 2 is about half a mile.

L. No. 3 is about one and a half miles north-west of No 2, and is separated from it by the same heavy beds of sandstone that form Bremo Bluff on the opposite side of the river. This lead is only about half a mile south-east of the great slate-belt. Where the ore-banks were formerly worked on No. 3 it is fifteen feet thick, and contains ore far superior to that of either No. 1 or No. 2. So far as it has yet been explored, its bedding is a softer micaceous slate than that of the others. From this the Dean Furnace was most largely supplied for some years, until its operations were suspended in 1848. During 1858 and 1859 it is said that large quantities of this ore were shipped to the Westham Furnace, now the Powhatan Iron Works, ten miles above Richmond. The three beds here described will furnish vast quantities of limonite ores, and these are known to have made good iron when worked alone. But the probabilities are that by admixture with magnetic and specular ores, which also abound in the county, iron of superior quality could be made.

I am indebted to C. Pardee, Esq., for a copy of the following analysis of an average sample of the ore of L. No. 3, made by Professor Britton.

| | | |
|---|---|---|
| Pure metallic iron, | 49.11 | per cent. |
| Insoluble silica and silicates, | 21.38 | " " |
| Sulphur, | none | |
| Phosphorus, | 0.71 | " " |
| Alumina, | 4.43 | " " |
| Lime, | 0.07 | " " |
| Magnesia, | 0.04 | " " |
| Manganese, | trace | |
| Titanium, | none | |
| | 75.74 | per cent. |

Such ore would undoubtedly make good iron alone, but still better by admixture with the specular and magnetic ores of the region, as above suggested.

The *Magnetic* and *Specular* ores of the Buckingham field have been explored sufficiently to show that they are extensive and abundant ; but while the leads evidently run with the general strike of the rocks of the country, that is at a mean of N. 25° E., the lines connecting the different openings have not been so well defined as to determine either the number or extent of the different leads. These ores are entirely different from the limonites described above, and altogether separated from them in position.

A few of the openings examined furnished nearly pure magnetite, but in a majority of them the magnetic and specular ores are intimately mixed, though in varying proportions. In the neighborhood of Willis' Mountain the magnetite evidently predominates in the mines that have been opened, while farther west the specular variety is more abundant.

As far as these ores have been brought to light by the limited explorations that have been made, and by surface indications, they seem to traverse the field in two somewhat distinct belts. The first, "M. No. 1," lies partly in Buckingham and partly in Cumberland—following the general direction of the line between the two counties. Surface specimens of ore have been found at a number of points, but the chief openings have been made in the neighborhood of Willis' Mountain. A few miles west of Ça Ira, near the road leading from that place to Buckingham C. H., developments have been made of very promising character. The lead has been traced for considerable distances, both N. E. and S. W.,—to the river a little below New Canton in the one direction, and beyond Willis' Mountain in the other.

It is undoubtedly a rich repository of ore, running east of Willis' Mountain, but not far from its base. What seems to be another branch of the same belt (M. No. 1) has been opened farther west; and if traced to a sufficient distance towards the S. W., it would pass the west flank of the mountain at some distance from its base—perhaps two miles or more. This group of ore-beds (for there are evidently several of them) seems to skirt the eastern border of the great gold-belt in this county. As the limonites of Buckingham have been traced into Fluvanna and Goochland, accompanying the gold-veins in those counties, so also have evidences of magnetic and specular ores been found in the same region.

The other belt (No. 2) of specular and magnetic ores—as far as can be determined from a few partial openings—runs near the western border of the gold-belt. Such is the inference drawn from an exploration made near Slate River, opposite the Lightfoot copper mine, where a vein of magnetite has been opened; and from the discovery of similar ores higher up the river. Near the new Philadelphia (Allen) gold-mine, farther to the south-west, a fine lead of magnetic and specular ore has been opened, only a few hundred feet from this newly opened gold-vein.

There can be no doubt that limonites, magnetites, and specular ores abound over a broad belt of Buckingham and part of Cumberland.

A promising vein of magnetite is found in Cumberland County, about four or five miles from Cartersville, and on the road leading from Cartersville to Dr. Walton's.

### THE BUFFALO RIDGE DISTRICT.

This title is given to the extensive iron-ore and limestone region traversed by the river from a few miles below Lynchburg to the neighborhood of Howardsville, a distance of thirty-five miles in a direct line, and bordering the S. E. flank of Buffalo Ridge. After cutting its way for some distance into the limestones and ores, with their imbedding slates, schists, and quartzites, the James changes its course abruptly from the S. E. direction, in which it runs for five miles below Lynchburg, towards the N. E., and by a somewhat serpentine channel follows in its general course the strike of the stratified rocks as far as Howardsville. There it deviates towards the east as far as Scottsville, where it resumes its south-easterly direction towards Richmond.

Parallel with the general course of that portion of the river between Howardsville and Lynchburg, and on both sides of it, are found numerous beds of iron ore of different kinds, with a number of heavy ledges of limestone, all included among still heavier strata of micaceous, chloritic, and talcose slates and schists, and the more durable quartzites and gneissoid sandstones that constitute the framework of most of the high ridges and cliffs along this part of the river valley. This same belt with its characteristic limestones is found traversing Virginia from Stafford County, on the Potomac, to Henry and Patrick, on the line of North Carolina. Beyond the S. W. limit of the James River district, but within the same broad belt, ores have been extensively mined in Franklin County and the N. W. portion of Pittsylvania, and shipped northward for the manufacture of Bessemer steel. But in that portion extending beyond Howardsville very little appears to have been done as yet, even to ascertain the extent to which these ore-beds may run in that direction.

The district here referred to begins near Howardsville in the S. W. corner of Albemarle County, and extends to the elbow of the river below Lynchburg. These ores are very much like those of the Buckingham district, both in variety and apparent quality. Here, as well as there, are limonites (brown hæmatites), magnetites, and specular ores—

the last two very much mixed. But a marked difference in the two districts is found in the abundance of limestone here and its absence there; while gold abounds there and is practically unknown here.

TOPOGRAPHY.—This district presents some topographical features quite different from those of the Buckingham district, and different, too, from what we find along any other part of the river. From the Blue Ridge to the great bend, five miles below Lynchburg, the river cuts the strata of rock nearly at right angles to their strike. Where these strata are very durable they form the framework of many ridges of moderate height, and of several ranges that rise to the dignity of mountain-chains—as for example the "Tobacco Row," in Amherst, and the "No-Business Mountain," in Bedford. These run off at right angles to the course of the river, and thus present a topography in that respect quite different from what we find farther down.

Below Lynchburg the stream sweeps around the S.W. end of Buffalo Ridge; then striking the Mt. Athos range a little lower down, it turns its course towards the N.E. and continues with the general strike of the rocky beds that support parallel ridges on both sides of the river. In its meandering course, however, the stream often cuts its way across one or more ridges, so as to leave a part on one side and a part on the other. The river valley is chiefly one of erosion formed by the cutting away of the softer beds of micaceous and talcose slate that lie between the harder and more durable beds of gneissoid sandstones and indurated chloritic slates. While the river thus follows the general strike of stratification, its tributary branches, which are all of moderate length and size along this part of its course, cross the lines of stratification transversely, and have cut channels for themselves of considerable depth. Thus with the windings of the river and the eroding action of its tributaries, the neighboring ridges are cut into portions of very moderate length—sometimes so short as to have become simply rounded peaks. In this way the region bordering on the river valley has become a deeply channelled plateau, varying in elevation from two to three hundred feet above the stream.

GEOLOGY.—The cutting up of this broad belt of country has laid bare its geological features, among the most interesting and valuable of which are its beds of limestones and iron ores. The great mass of rocky beds consist of strata of micaceous, talcose, and chloritic slates alternating with one another or with the harder strata of gneissoid rocks and quartzites. The limestones are generally in very continuous beds, some of them of considerable thickness, and are more closely associated with the slates than with the harder rocks. Such is also the case with the limonite ores, though they have not the same regularity of bedding as the limestones. Still beds of these ores sometimes extend for several miles with considerable regularity, as will be shown hereafter.

The specular and magnetic ores are closely associated with the harder rocks, generally imbedded in them ; deposited originally as limonites, and subsequently changed by metamorphic agencies into their present anhydrous and crystalline condition.

The prevailing dip of the whole series of strata not only here but throughout the greater part of Piedmont and Middle Virginia is toward the S.E.—due in many cases to "faults," and to uplifts and folds having their crests tilted over toward the N.W.—but normal north-western dips are still of frequent occurrence.

The bearing or strike of the upturned edges of the strata in this whole region under consideration has considerable regularity—being generally about N. 40° to 45° E., and nearly parallel with Buffalo Ridge and its continuation, Findlay's Mt.—but it is far from being invariable. So that beds of limestones and ores following the same rule cannot fairly be represented by straight lines, except so far as these might represent general courses from point to point. The accompanying map will show approximately the lines of outcrop of some of the most important mineral beds. The limestones are indicated by blue, the limonite ores by reddish brown, and the specular and magnetic ores by red lines.

The geological section, No. I. p. 39, represents a profile of the stratified rocks cut by an imaginary vertical plane crossing the valley of the river near Gladstone. It will help to throw light upon the relative position of the principal rocks and the ores they carry with them. The quartzites and gneissoid sandstones (which generally blend into each other) are represented on the section by dotted bands; the schists and slates are ruled; the limestones blocked and colored blue, and the ores colored red, as on the map. The beds of limestones and ores seem not to be equally numerous at all points along this part of the belt. Indeed it is not surprising that some of them should run out in some part of their course, and again reappear, or perhaps never be found further on. This on a small scale is just what is of frequent occurrence on a larger scale in our continental geology, and even in the more limited geology of Virginia. Variations in continuity, in thickness, and in purity of sedimentary deposits must necessarily result from a want of uniformity in the surface on which they are deposited, and from other attendant circumstances.

The limestones, however, are here, as in nearly all geological formations, more uniform and continuous than the ores. Still the beds of the latter, as stated above, have a remarkable degree of continuity in this region, and the limestones serve as valuable guides in tracing them from point to point.

The value of these limestones for fluxing will be noticed in another connection.

An interesting feature in the geology of this region is the number and extent of the igneous masses that have been thrust up through the stratified rocks as trap-dikes, that cross the lines of stratification, sometimes at right angles and sometimes obliquely. When they are thin, as they usually are on the higher grounds remote from the river, they break up into blocks that, on exposure to the weather, become almost as round as river boulders. Their shape and dark rusty color have given them the vulgar name of "nigger-heads." Where the beds have been eroded to a considerable depth they generally present a much greater thickness than they have at higher elevations, and a distinctly crystalline structure; in other words, they are syenitic granite.

Examples of the peculiar crystalline arrangement of their constituent minerals, hornblende, feldspar, and silica, can be seen at Dr. White's, a little way above the mouth of Bent Creek, and on the opposite side of the river near the residence of Dr. Megginson; also on Porridge Creek and some other streams that flow into the river.

This syenite makes a very superior building-stone, and was quarried near Harris's Creek, a few miles above Greenway, for masonry on the canal. Its hardness makes it difficult to work, but in every other respect it is a valuable building material. These igneous masses are of more recent date than the beds that carry limestones and ores, and by their upward and lateral thrusts have often displaced and sometimes contorted the older rocks through which they have passed. Such disturbances occasionally break the continuity of leads of ore and increase the difficulty of tracing them. They are therefore important subjects of study for the explorer as well as the miner.

The leads of ore may now be traced with more detail.

THE LIMONITES.—These embrace what are known locally as "brown hæmatites" and "pot ores." In some places they seem to be accumulated in extensive pockets, but in other places I have been able to trace them for many miles in regular beds. As before stated, they are commonly associated with the beds of slates, and in most places quite contiguous to the limestones.

In former times the limonites were almost the only ores worked in the old furnaces in the James River valley; but now they seem to be receiving less attention than their true value appears to demand. Their abundance, the low cost of mining them, their easy reduction in the furnace, and their richness in iron are important circumstances in their favor. And although they may not make good Bessemer steel, they may yet be found to work well in mixture with some of the poorer grades of specular and magnetic ores that abound in the same vicinity, and thus produce a grade of metal much superior to that producd when they are smelted alone; though the iron they yielded in former times is said to have been good for all ordinary purposes.

Among the regular beds accompanying the beds of limestone the following may be mentioned:

1. On the estate of Dr. Peters, two or three miles north-east of Norwood Station in Nelson County, is an opening in a large bed of limonite

apparently of good quality. This is not far from the S.E. base of Buffalo Ridge, and has been traced in a belt parallel with the Ridge for a considerable distance towards the south-west. Its extent makes it an object of interest.

2. Near Greenway, in the same county, a heavy ledge of limestone crosses the river, and extends for half a mile up a small branch. About fifty yards to the S.E. of this limestone is a partially opened bed of limonite, 3 or 4 feet thick, enclosed in mica slates, and, like the limestone, dipping to the S.E. at an angle of about 50°. The same limestone appears again on Rich Creek, a few miles farther to the S.W., and the bed of limonite is found accompanying it on the same side, but at a little greater distance. This is found on the estate of Dr. B. C. Megginson, so situated as to be easily mined. The probabilities are that the same ore occurs on the Buckingham side of the river below Greenway.

3. Not very remote from this locality, but a little more to the N.W. on Elk Creek (also called Allen's Creek), in Amherst County, is found the bed of limonites, 6 or 8 feet thick, from which most of the ore was mined that formerly supplied the old Elk Creek furnace, long since out of blast. This ore lies N.W. of a considerable ledge of

limestone, or rather between two ledges, and, like most of the other beds of the same kind of ore, it is enclosed in soft mica and talcose slates. The old mine could be easily reopened and extended, and the ore readily transported to the river. Prof. Rogers, who was there when the furnace was in operation, says: "Half a mile westward occurs another bed, consisting principally of slaty and micaceous ore (specular), and at various points in the vicinity bog ore (limonite) is abundantly met with, serving a useful purpose, *in union* with the compact and micaceous ores." I mention this as an example of the advantage of working mixed ores in the olden time.

The main Elk Creek lead traced toward the S.W., appears again on the lands of the Central Virginia Company and on the estate of Mr. Charles N. Christian, where it has been opened and displays a thickness of 8 to 10 feet. On the lands of S. Branch Walker it has also been opened with a thickness of 8 feet, still carried in mica and talc slates. Ores from these mines can be readily brought to the railroad at a trifling cost.

4. About a mile above Christian's Creek is an old mine near Mr. Chas. Pettijohn's that was worked some years ago by the Dover Company. It has surroundings very similar to those of the

places above mentioned, and is evidently in about the same range. The natural inference, therefore, is that it is a prolongation of the Elk Furnace lead. This is near the railroad, and will no doubt furnish large quantities of ore.

5. The openings of limonite ores have not been made on the north side of the river, higher up than the old Dover mine just mentioned. On the Appomattox side, however, there are some very extensive beds that claim attention. Nearly opposite the Walker's Ford Station, on the estate of Messrs. Jones & Button, what is known as the Nutall vein (or lead) presents a fine display of limonite not less than 12 feet in thickness. It lies about 100 yards S.E. of a broad bed of limestone that crosses the river not far below this point, and that closely resembles the large Greenway ledge in extent, texture, and dip. A smaller bed of limestone occurs a short distance farther to the N.W. The dip of both limestones and ore is S.E. 55°, the strike N. 40° E. About thirty yards farther to the S.E. is a bed of peroxide of manganese, that promises to be valuable as a secondary object of mining operations here. Both of these beds, the limonite and manganese, can be traced for a considerable distance towards the S.W. The relative position and general characteristics of these limestones and ores,

as well as their strike, favor the conclusion that their continuation is found near the old furnace on Stonewall Creek, and that they are there represented by what Col. McDonald, in his report on the Birmingham Company's property, speaks of as "two extensive limestone formations carrying a burden of brown hæmatites and impure manganese oxides." N.W. of this a short distance, is an opening from which large quantities of ore were mined many years ago, and near the same locality a great abundance of this ore is brought to view in a shaft sunk recently by the Birmingham Iron Company.

About a year ago I visited an opening on a bed of limonite near the headwaters of Stonewall Creek, probably two miles farther toward the S.E. than the Stonewall furnace beds, and apparently in the same lead.

The limonites in this whole Buffalo Ridge district seem to be real, though somewhat irregular, geological beds. In this respect they resemble the beds of limonites found in the Cambrian and Silurian formations west of the Blue Ridge, though the latter appear to have less irregularity of structure than those in this James River belt.

The real value of these limonites has been fully and fairly tested in the furnace, and the iron they have produced has been extensively employed in the foundry and the forge. It is therefore a settled question that they yield grades of metal adapted to all ordinary uses. They may not make Bessemer steel, but with a due admixture of other ores they may be found to produce good car-wheel iron.

A few examples of the analyses of some specimens will show their richness in iron, and their comparative freedom from injurious substances.

| Localities. | Metallic Iron. | Phosphorus. | Silica. |
|---|---|---|---|
| 1. W. A. Payne | 53.01 | 0.135 | 11.26 |
| 2. Riverville | 52.26 | 0.946 | 6.25 |
| 3. Stapleton | 56.38 | 0.110 | ... |
| 4. Stonewall Furnace | 55.20 | 0.260 | 7.14 |

Specular and Magnetic Ores.—For convenience the Buffalo Ridge district has been divided into sections—marked off by transverse lines—as follows: the area between Howardsville and New Market, the Warminster section; between Tye River and Christian Creek, the Greenway section; between that and Stovall Creek, the Stapleton section; and the remainder of the belt, as far as the great bend of the river below Lynchburg, the Mt. Athos section.

The true position, extent, and probable value of the ore-beds in these several sections will be best understood by looking at the extensive district as a whole, with reference to some leading characters common to all parts of it.

1. As heretofore stated, the rocks here are all stratified, and have been upturned and folded with such uniformity as to be nearly parallel throughout their whole extent, with a strike nearly north-east and south-west.

2. The chief varieties of rocky beds are quartzites, gneissoid sandstones, mica, talcose and chloritic schists and slates, and beds of limestones.

3. Interstratified with these rocks are found the beds of ore, numbering in all more than twenty-five,—designated by Nos. 1 to 25, with some half-numbers intervening,—differing very widely in the extent and richness of their ores. Hitherto only a few of this number have been worked profitably, such as 6, 6½, 10½, 11, and 16. Some of them seem to be continuous throughout the whole field, but there is reason to believe that many of the smaller beds are wanting over considerable areas. While specular ores predominate, they are frequently mixed with magnetite, not apparently to the same extent as in Buckingham, though some of the leads are almost exclusively magnetic.

4. The larger beds of ore, as far as examined, range in thickness between 2 and 6 feet. One peculiar feature of their internal structure is that the ore is found in lenticular masses overlapping one another, but with partings of schists or slates be-

tween them ; so that while the rich ore often fills up more than half the vein, it more frequently fills less than half, the remainder consisting of poor ores and "gangue." The following figure will help to illustrate this structure:

Figure 1 is intended to show the position in which the lenticular beds of metamorphic ores (specular and magnetic) are found in the veins.

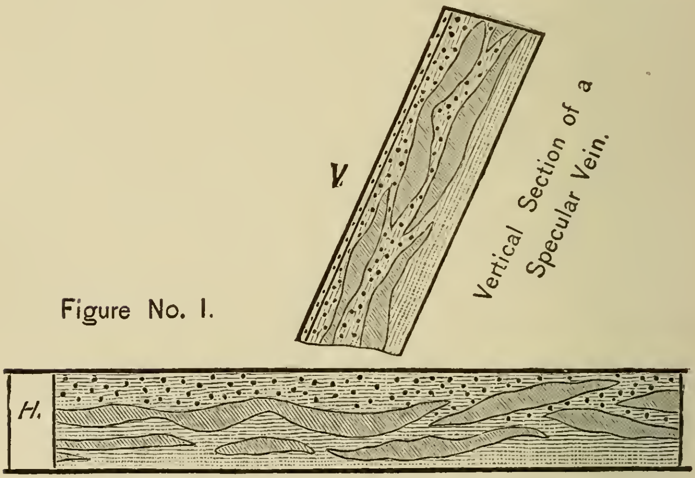


Figure No. I.

Horizontal Section of Specular Vein.

The dark portions in H represent the appearance of the ore-beds of a vein supposed to be cut by a horizontal plane, while V represents the same beds cut by a vertical plane, crossing at right angles to the strike. Here the hanging wall is sandstone and the foot wall slate.

WARMINSTER SECTION.—In and immediately around Howardsville the archæan rocks are all covered by the remarkably coarse conglomerates, red sandstones, and red shales of the Mesozoic age. But these are cut through by Rockfish River and other smaller streams, so as to expose the older rocks beneath; and in these some promising developments of specular ore are said to have been recently made at a short distance north-west of the village. From this circumstance, and the continued similarity of the rocks, there is reason to believe that many of the leads of Nelson County run far into Albemarle.

Between Howardsville and New Market prospecting has been carried on to a sufficient extent to develop some fine exposures of ores, but it would be premature at present to attempt to classify or number the leads here exactly as they have been numbered in the Greenway section, where more thorough explorations have been made. In fact, the continuity of the thinner beds is very doubtful.

On the old Peters tract, locally known as "Sleepy Hollow," is a bed of specular ore about 5 feet thick, and of the usual internal structure. This is supposed to be the same as the chief lead of the Greenway mines (No. 16.) About 200 yards north-west of this is the heavy bed of limonite mentioned above, which crops out at other points about equally distant from the base of Buffalo Ridge; and about the same distance south-east of the specular bed is a heavy ledge of limestone, some portions of which seem to be of good quality. The great loop of the river between Warminster and New Market must include nearly the whole of the specular ore-belt, and is therefore an inviting field for explorations.

If a line were drawn with the strike of the beds of limestone and ores from Greenway to Hardwicksville, it would cut off the great bend of the river between those two points, and with it a large area in Buckingham opposite the mouth of Tye River, through which the Greenway, Riverville, and other beds of specular and magnetic ores must pass—I mean those that cross the river at Greenway or a little below. Nos. 6, 10, and 11 ought to pass to the south side of the river, and continue on that side for several miles, while the leads of the Greenway mines may also cut off a part of the loop opposite the mouth of Tye River.

On the south side of the river at Greenway specimens of what seem to be light bog ore are found. There is also an outcrop of specular ore a short distance below Greenway, very near the margin of the river. This is probably in a prolongation of one of the beds displayed near Riverville. On the land of

B. R. Eldridge, Esq., of Buckingham Court-House, a shaft about 8 feet deep had been sunk on a bed of impure magnetite which improved as the depth increased. Another opening of the same kind on the same lead gave similar indications.

This whole section south of the river is worthy of a more thorough exploration than has yet been made.

The Greenway Section has been more fully explored and more extensively worked than any other. The vein, or lead, No. 16 is regarded as the typical vein of this region. It has been so far developed as to establish great uniformity for 8 miles, and has a range of thickness from about 2 to 6 feet. The mine is on a ridge that is more than 250 feet above the river, and from it large quantities of ore have been mined and shipped. What is regarded as No. 15 has been opened in the neighborhood of the Greenway mine, and appears to run through the "Mink Hollow" tract. Farther on this bed has been opened by short tunnels on opposite sides of a ravine; it is about 6 feet thick, and has a strike north 45° east and a dip of 70° towards the south-east. On Mr. Matthews' land a bed of 4 feet good ore has been opened—probably in No. 6.

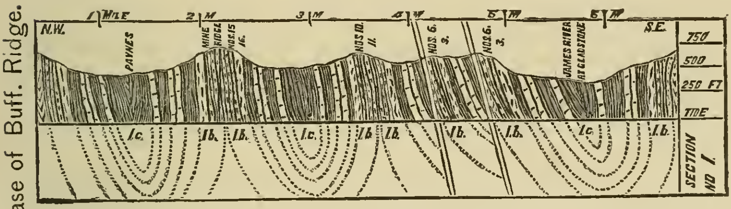
On Buck Ridge several promising openings of specular and magnetic ores have been made near Greenway village.

Between Gladstone and Allen's Creek stations mines of specular ore mixed with magnetite have been opened, from one of which 500 tons of ore were shipped to the Powhatan Iron Works. In this mine the bed, with the usual partings that accompany these ores, occupies a space of 12 to 15 feet. To the south-east of this, about 200 feet, is another bed of softer micaceous ore of less thickness, but promising both in extent and quality.

On Allen's Creek (formerly called Elk Island Creek) is situated the old Elk Creek furnace, mentioned above. Near the furnace, mining in two specular beds is carried on to supply ore for the Lynchburg furnace. One of these was opened long ago, the other recently. These are probably what are known as 6 and 6½. Indications of the same leads are found on the adjoining properties. The ore from the vein mined for Elk Creek furnace was formerly smelted in mixture with the limonites of the same neighborhood (charcoal being the fuel employed), and is said to have produced iron of superior quality.

Section No. 1, as already stated, represents a vertical plane, supposed to cut all the strata from a point on the south-west side of the river, a short distance above the mouth of Bent Creek, to the base of Buffalo Ridge. It will be seen to embrace three synclinal folds and two faults, or slips, that cut off portions of the strata from the main mass. It must be regarded as provisional—to be rejected, modified, or confirmed by more numerous developments and closer inspection hereafter. It is offered as giving, probably, the most satisfactory solution of the relative positions of the outcroppings in this portion of the iron and limestone belt.

(Section No. 1.)



Provisional Section. From Base of Buffalo Ridge to River at Gladstone.

Three general classes of rocks are represented on the section: (1) sandstones, quartzite, etc.; represented by the dotted bands; (2) chloritic and talcose slates, represented by bands with short longitudinal lines; (3) the softer talcose and mica slates represented by closely ruled bands; (4) the limestone beds, divided into blocks; (5) iron-ores, colored black.

While the outcroppings of limestone are numerous, they may all be referred to two conspicuous beds, with some minor ones that are only local. The workable veins of magnetic and specular ores are probably referable to three or at most four original horizons, now repeated several times by the folds and faults represented in the section. There are minor veins, but they seem to be in some cases only branches of the larger ones, and in other cases only local in extent.

A discussion of the theoretical considerations that have led to the construction of this section must be reserved for some future time. For the present I aim to show the most probable position in which the valuable minerals will be found among the imbedding rocks, as a guide to future explorers.

RIVERVILLE SECTION. — Passing a few miles farther up the river a number of openings were found near Riverville, on the property of the Central Virginia Mining Co., supposed to be on the beds numbered 6 and 6½. One of the most interesting of these is a new opening by tunnel worked since November, 1880, and from which ore is said to have been mined at the rate of 200 to 300 tons per month. The ore is a mixture of specular and magnetic, and is assorted into two grades, the first grade chiefly magnetic, the second chiefly specular. The thickness of this bed is about 3 feet.

These Riverville leads have been traced through the property of Mr. S. Branch Walker, where openings have been made sufficient to promise most favorable results from future mining operations. On the same property developments of limonites have already been mentioned, from which the ores can be readily obtained for mixture with the magnetic and specular ores adjacent to them, and both of them easily carried to a good furnace site near the railroad.

On the land of Mr. J. R. Boteler, adjoining Mr. Walker and near Limekiln Creek, an interesting mine has been opened by a shaft to the depth of more than 100 feet, from both sides of which drifts are run along the lead for considerable distances. The dip, the general direction of which is followed by the shaft, varies considerably, being at first about 60° south-east, and becoming vertical at the depth of a little over 100 feet. The hanging wall (south-east) is a hard sandstone, while the foot-wall is a soft talc and mica slate. The ore is the usual mixture of specular and magnetic varieties.

The veins above mentioned seem to reappear on the lands of Messrs. Turner, Pettijohn, and Mrs. Lee, farther toward the south-west, where we reach the Stapleton section. As a considerable portion of this section is on the Appomattox (south-east) side of the river, it will be proper to return to the lower limit of Appomattox County.

On the estate of Dr. J. F. White and brothers on Bent Creek an opening has been made on a bed of specular and magnetic ore about 4 feet thick, with a strike north 45° east and dip south-east 70°; but the opening is not sufficiently deep to exhibit the true quality of the ore. Surface indications have been traced to some distance south-west on the same lead. Still farther up the river, and near the mouth of Wreck Island Creek (locally called Rack Island), I found miners at work on a bed of tolerably pure magnetite, closely associated with a bed of white limestone (or marble). The prospecting was said to be in search of copper ore.

On the farm of Messrs. Jones & Button near Walker's Ford, a locality already mentioned in connection with the Nutall limonite bed, there are found surface fragments of specular and magnetic ores south-east of the large beds of limestone that run from here to Stonewall Creek, thus giving reason to suppose that beds of these ores, as well as the great bed of limonite, may be found in the same relative position here that they occupy there. Here we reach the borders of the Stapleton section on the south side.

If these ores on the south of the river should be fully and extensively developed, the fact that they are separated from the railroad by the river will be no serious impediment to their being extensively utilized. For wherever they are found in abundance means will be readily devised for their transportation to the line of the road.

The *Stapleton Section* on the north side has an excellent representative in what is known as the Maud vein (No. 16), opened by the Central Virginia Company on Porridge Creek about a mile from its mouth. The vein has been penetrated along its strike by several tunnels. One of these after reaching a distance of 800 feet came upon a sudden interruption of the vein by sandstone like that forming the foot-wall. This was due most probably to a local fissure and slip in the strata. The next tunnel, on a lower level, had been run along the same vein for 140 feet, and the thickness, where exposed, was 2 feet of good ore. Other tunnels have been driven upon some less promising veins in the same vicinity, but their value has not been fully determined. These veins are mixtures of specular and magnetic ores, and by sorting and washing they are divided into two grades, the best of which alone is regarded as worth shipping to a distant market. A bed of limestone occurs about 200 yards south-east of the Maud vein.

Prof. Kimball, in his report on this region, says: "The demonstrated value of the Stapleton tract is chiefly in the Maud belt of ores, which have a fine range on the property and are among the richest in the region."

Charles Pettijohn, Esq., informs me that several veins of magnetic and specular ore have been opened on Mrs. Lee's property adjoining him, and among them the Maud and Greenway system. These are a short distance north-east of Porridge Creek, and therefore well situated to give fully as good results as have been attained in the valley of that creek by the operations of the Central Virginia Company.

After passing Porridge Creek the veins of ore and beds of limestone that have hitherto occupied the north-western portion of the river belt either run out or have not yet been discovered. On Stovall Creek, which enters the river at Galt's Mill two miles above Stapleton, the limestones are not found, and the only representatives yet discovered of the ores are some lean veins of specular ore found in hard micaceous sandstones about two miles from the mouth of the creek. The natural inference is that the north-west synclines of the belt that carried beds of limestone and ore, as represented on Section No. 1, have here lost their burden of these minerals, and have nothing left but their sandstone bottoms with occasional beds of lean ore interstratified.

On the south side of the river nearly opposite Stapleton, along the valley of Stonewall Creek, several openings have been made on the Ferguson and Isbell properties, displaying good specular and magnetic ores, supposed to be so abundant as to afford profitable mining. Then in the same region the hematites of the Legrand and Bocock lands, and the old beds of the Stonewall furnace heretofore mentioned, are important features of this division of the great ore-belt.

A mile or two farther to the south-east are evidences of the sandstone margin of the hypothetical synclines represented on the south-east portion of Section No. 1, and in it are indications of both specular and magnetic ores.

The *Mount Athos Section* is embraced chiefly in the property of the Birmingham Iron Company. The greater portion of it, so far as developments have been made, lies on the south side of the river. But if the "Maud vein" should be found continuous toward the south-west, it ought to run into this section on the north side. In fact, on Stovall Creek about two miles above Galt's Mill, as stated above, a bed of lean specular ore about 18 feet thick has been opened that appears to be in a prolongation of Round Top Mountain. It seems too different in character, however, from the Maud vein to be regarded as its prolongation. Its value has not been demonstrated.

On the south side the Mt. Athos section is in realty a prolongation of the south-western portion of Riverville and Stapleton sections. There seems, however, to be a general contraction in the width of this belt of limestones and ores as we approach the region of Mt. Athos. The total width from the hills that skirt the south-east base of Buffalo Ridge to a line connecting the highest points on Bent and Wreck Island creeks at which we could find any limestones, or hear of any having been discovered, is about 6 miles. Near the line of the Norfolk and Western railway, 18 miles farther to the south-west, the demonstrated width of the belt cannot exceed 4 or 5 miles; though the examinations were not so thorough here as at points lower down the river.

It seems at least probable that the portion of the great mineral belt embracing the Greenway mine and Nos. 10 and 11 of the Greenway section is embraced in two closed synclines that gradually rise in a south-west direction, and run out at some point between Porridge and Stovall creeks. The fact that no corresponding beds of either limestones or ores have been found extending any farther to the south-west seems to favor this theory, but for the present I only offer it as a theory to be established or set aside by future and more extended observations.

At the south-east end of Mt. Athos and near the N. & W. R. R. the Birmingham Company ran a tunnel, some two or three years ago, into a bed of specular and magnetic ores, which is most probably a prolongation of bed No. 6 of the Riverville series. A short distance farther to the south-east other beds of similar ores have also been opened, and ore of good quality obtained. Judge Williams, President of Birmingham Iron Company, in a recent letter says: " In that central portion in the region of Chestnut Mountain and Joshua Creek for some reason the ore deposit seems swelled out and is broader, the veins more numerous, thicker, and richer, than either north or south of it. There seems also a much larger deposit of red hematite than elsewhere in the belt that has come under my observation ; and I think by *far* the heaviest deposits of good ore are to be found in this vicinity."

At the time of my visit there in the summer of 1880 no work was going on, and I had no convenient opportunity of examining the interior of the tunnels. But on this subject I shall take the liberty of quoting from the valuable report of Col. McDonald on this "Portion of the James River Iron Belt." He says, pp. 12, 13, 14:

"At the south-west end of Mount Athos the Birmingham Iron Company have run a drift from the level of the railroad about 100 feet into the mountain, following the ore. The distance between walls is from 7 to 8 feet. The ores are specular and magnetic; the magnetic predominating. The width of ore running over 50 per cent is from 1½ to 2 feet. The balance by sorting would yield a large proportion of ore, running from 30 to 35 per cent, which being disseminated in a soft gangue could be cheaply crushed and concentrated by washing."

"Near the railroad the Birmingham Company have driven a tunnel from the south-east side to intersect the system. The last fifty feet of the tunnel is in ore (specular and magnetic)."

"In this same ore system, but west of the range above indicated, is a very rich and pure specular ore, which has been worked by the Birmingham Company, by a slope shaft, to a depth of ninety feet. A section at bottom of shaft shows eighteen inches to two feet of rich specular ore, six feet of lean ore, and on the foot-wall a seam of very rich crystallized pyrolusite several inches in thickness."

The 60 and 75 feet veins mentioned by some writers as found in this great river-belt were not discovered during my researches,—unless they refer to groups of beds separated by wide partings of gneissoid sandstones, schists, and shales; the real ore-beds being quite narrow.

This James River belt, with its heavy ledges of limestone and its fine beds of magnetic and specular ores, extends far to the south-east of the point to which it has been followed in this discussion. From it are derived the fine steel ores now extensively mined in the north-western part of Pittsylvania County, and shipped north to be smelted. I hope the time will soon come when numerous and extensive furnaces will be built along the James, that will offer a home market for all ores within their reach.

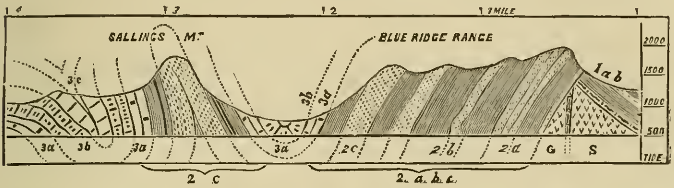
The results of the chemical analyses of these ores are interesting as showing their richness in iron and the low percentage of injurious substances contained in them. The following are examples:

| LOCALITY. | Metallic Iron. | Phosphorus. | Silica. |
|---|---|---|---|
| Greenway mines—from Kimball's report: | | | |
| No. 1, Vein 16 | 66.32 | 0.035 | 3.29 |
| No. 7, “ | 66.62 | 0.022 | 3.96 |
| No. 8, “ | 64.84 | 0.049 | 6.07 |
| No. 9, “ | 65.80 | 0.037 | 6.36 |
| No. 14, Harris Tract | 61.12 | 0.088 | 7.68 |
| Riverville Section: | | | |
| No. 1, Vein 6½ | 66.23 | 0.023 | 4.37 |
| No. 12, Vein 3 | 65.71 | 0.009 | 4.10 |
| No. 14, Vein 6 | 65.70 | 0.046 | 3.04 |
| Mount Athos—from other sources: | | | |
| No. 1, Mount Athos mine | 63.97 | 0.048 | 3.14 |
| No. 3, “ “ “ | 57.68 | 0.035 | 14.67 |
| No. 4, “ “ “ | 64.85 | 0.001 | .... |

The above samples indicate ore of first grade.

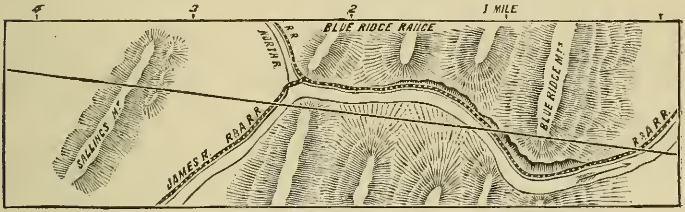
Between Lynchburg and Balcony Falls the trend of the river is almost at right angles to the course below, and hence cuts the strata transversely. Along this part of the river ores have been discovered, and to some extent opened, that promise profit to their owners in mining. They are chiefly magnetic found near Pedlar River, a branch of the James from Amherst County ; and in the neighborhood of Coleman's Falls (Phelps P. O.) on the Bedford side. This appears to be a prolongation of a bed of magnetite found at several points in Amherst County a little north-west of the base of Tobacco Row Mountain. From what is known of it near the railroad on both sides of the river, it promises valuable results from more extended explorations and developments.

PRIMORDIAL OR BLUE RIDGE BELT.—After ascending the James above Lynchburg for a distance of 25 miles, we leave the Archean rocks and pass to those of a less remote age—the Cambrian or Primordial, as they are called by geologists. Here, where the two branches of the R. & A. diverge, is found the second great belt of iron-bearing strata skirting the north-west slopes of the Blue Ridge range throughout its whole distance from the Poto mac to the Tennessee line. Its extent and importance are illustrated by the fact that from it the great Shenandoah Iron Works of Page County have been supplied with ore for a long time, and from it the old Torrey and Cotopaxi Furnaces of Augusta, the Buena Vista and Glenwood furnaces of Rockbridge, and the Arcadia and Cloverdale furnaces of Bote-



N. W. No. II. Section at Balcony Falls, James River. S. E.

(Section No. II. to accompany page 51.)



Map of Canon at Balcony Falls, Virginia.

Section No. II. represents the great natural section made by the river at Balcony Falls. G. and S. on the right are igneous rocks, granulite and syenite, that form the core of the Blue Ridge proper; while 2 *a*, 2 *b*, and 2 *c* are very general divisions of the Primordial formation that makes up the great part of the north-western slope of the range. Sallings Mountain is an outlier of the same range, and composed in part of the same Primordial strata, in the condition of a closed anticline partially inverted. In this, as in all the subsequent sections, sandstone beds are dotted, shales and slates ruled, limestones (3 *a*, 3 *b*, and 3 *c*) blocked, and iron ores colored black.

tourt were fed for many years without any symptoms of exhaustion of ores.

The largest deposits of ore in this bed are limonites, but what are regarded as very valuable beds of the hard variety of specular, here called "block ores," are found to be extensive on both the Glenwood and Arcadia iron properties, as will be more fully stated below.

This belt is of such importance as to claim a somewhat detailed examination, especially as at all periods of its history for a century past its ores have produced those grades of iron that uniformly commanded good prices in market. (See map, and geological section No. II., p. 51.)

Beginning, then, with the portion north-east of the pass at Balcony Falls, and lying for several miles of its extent between the R. & A. R. R. and the mountains, we find within the first two miles some extensive openings along the north-western slope of the mountain on the Dover property, from which many thousands of tons of ore have been quarried, rather than mined, and carried down the canal to be smelted in the Amherst and Westham furnaces. A more systematic method of mining than that formerly pursued here would reach a far greater quantity of ore than has heretofore been taken from these beds.

The same formation of Primordial shales extends still farther along the base of the mountain through what is known as the Brady property, where it has been only partially developed, but where there are indications of ore in abundance. On the same property is an excellent site for a furnace immediately on the railroad line.

Next in order comes the extensive Buena Vista estate, on which ores have been mined for a century. Here the great stratum of ferriferous shale with its leads of ore is multiplied by a fault, and by several folds, such as are represented on the profile section (No. III., p. 57) drawn through the Glenwood property, and cutting its various rocky beds at right angles. On this the different classes of rocks are distinguished from one another as stated in the description of this section.

Within that portion of this belt lying between Balcony Falls and White's Gap, the limit of the Buena Vista property, the longitudinal extent of ore-beds, varying from 5 to 20 feet in thickness, is not less in the aggregate than 20 miles—taking re-duplications into the account. This ore can all be carried by down grades to furnace sites easily procured on the line of the R. & A. R. R. and on the margin of North River, with abundant supplies of water.

Large bodies of timber in this region will yield charcoal enough to run one or more furnaces for many years. The ores of the Buena Vista property have been employed for several years in the Amherst furnace below Balcony Falls; and have been smelted with charcoal, producing an iron that has for some time past commanded an average of $35 per ton.

This extensive belt runs on through Rockbridge, Augusta, Rockingham, Page, and other counties till it passes the Potomac.

Returning now to the main stem of the railroad, we find it skirting the margin of another extensive division of the great Primordial belt, extending from the pass of the James at Balcony Falls towards the south-west far beyond Buchanan. We shall not follow it, however, much farther than the limit of its availability as a source of traffic to this railroad. Within this limit it is covered chiefly by three large tracts of mineral lands, the Glenwood, the Arcadia, and the Cloverdale properties. On two of these I have made special reports for the proprietors, from which additional information can be obtained. (See "The Virginias," July, 1880.)

The geological disturbances at Glenwood, as at Buena Vista, have re-duplicated the exposures of ore. An irregular line or group of outliers of the Blue Ridge has been thrust up through the limestones of the Great Valley, at a distance of two to three miles from the main ridge. Among the conspicuous features of this group are Salling's and Skillern's mountains, with a limestone trough between them, through which the James passes just above Greenlee's Ferry. These outliers, as well as the main range, carry with them valuable beds of ore in the same Primordial shales already mentioned. (See geological secs. Nos. II. and III.)

In Skillern's Mountain, and in the valley of Matt's Creek, on the Bedford side of the Blue Ridge, specular ores of the "block" variety are found in great abundance. The same ore is also found in large quantities on both the Arcadia and the Cloverdale tracts.

The accompanying map shows the position of the leading outcrops of ore in this belt.

These ores exist in vast quantities all along this portion of the belt, as well as in that portion contiguous to the Lexington branch of the road, and are in convenient distances of railway transportation, and excellent furnace sites.

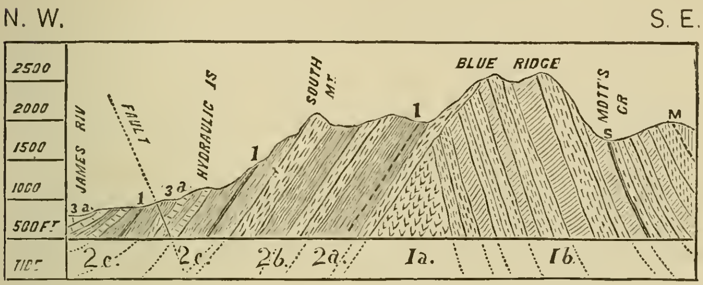
The following extract from my special report on the Glenwood estate, as to "*quality of the ores*," will apply equally well to the whole of this section: "While chemical analyses, such as are given in the table below, when properly made are reliable, and for average samples taken from the general run of the mine are valuable, there is no test of ore so trustworthy as that resulting from its long-continued use in the furnace, and the varied application of its products in the industrial arts. The history of an ore, and of the iron made from it, is the most reliable criterion from which to judge of its true value."

Table of Analyses of Primordial Ores.

| | Metallic Iron. | Sulphur. | Phosphorus. | Silica. |
|---|---|---|---|---|
| *Limonites.* | | | | |
| From Glenwood.................. | 51.58 | 0.01 | 0.22 | 9.96 |
| " " .................. | 55.60 | trace | 0.55 | 3.98 |
| " Irish Creek................ | 56.25 | 0.02 | 0.52 | 8.75 |
| " Arcadia (aver. of 7 samples).. | 48.83 | .... | 0.62 | .... |
| Averages.................... | 53.07 | 0.02 | 0.48 | 7.56 |
| *Specular Ores.* | | | | |
| From Glenwood.................. | 44.55 | trace | 0.030 | 21.50 |
| " " (Archean)......... | 50.00 | trace | 0.023 | 20.88 |
| Averages.................... | 47.28 | .... | 0.026 | 21.19 |

Good car-wheel iron has been made from the first two. The last two promise favorably as steel ores.

*The Upper Cambrian*, 4 *a*, *b*, *c*, or *Trenton* of N. Y. (III. R.) carries in its highest bed of shales (Hudson) some valuable limonite ores. They are well represented on Purgatory Mountain, near Buchanan. The old Etna and Retreat furnaces in this neighborhood were once supplied with ores from the Hudson shales that crop out largely on the eastern face of Purgatory; but these were subsequently abandoned for the superior ores of Clinton or Upper Silurian shales, found in great abundance along the margins of a little valley lying between Purgatory and May's mountains.



Section No. III. Crossing Blue Ridge near Glenwood.

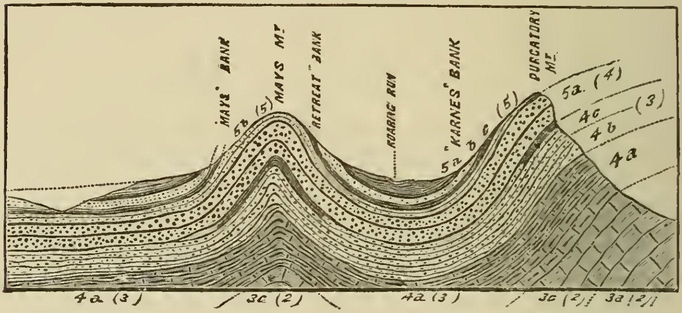
Section No. III. cuts the Glenwood property three miles above the mouth of North River. On the south-east side of the Blue Ridge are metamorphic rocks, which also constitute the main body of the ridge. They are indicated as 1 *a* and 1 *b*. The red belt, marked S, is a bed of block ore. On the north-west side of the ridge are primordial sandstones and slates with their beds of limonite ores (2 *a*, *b*, *c*); and the lowest of the valley limestones—3 *a*, 3 *b*, and 3 *c*.

The "fault" near the left of the figure has doubled the outcrop of the ore-bed of 2 *c*. On the Buena Vista property, mentioned farther back, a similar fault occurs, and besides this a fold, which increases the exposures of ore to a still greater extent.

Catawba furnace in Botetourt County was supplied with ore from the Hudson shales, and made iron of good quality. At that point this ore is said to be very abundant still.

The *Medina* and *Clinton* groups 5 *a, b, c* (IV. and V. R.) of the *Upper Silurian Period* constitute almost everywhere the repositories of ores of superior quality, but not usually very abundant in quantity. They are generally characterized by a soft slaty structure, with some beds of ochery texture; while others occasionally occur of decidedly nodular and massive structure and of considerable extent, as in the Purgatory range. Ores of this age are often found very full of fossil remains, and hence called "fossil ores;" in other localities, and especially in the upper beds, the structure is decidedly shaly, and the color deep red—hence called "red shale ores"; while in South-west Virginia and East Tennessee, where this geological group is rich in ores, the

Section No. IV.



Geological Section of Purgatory and Mays' Mountains, Botetourt Co., Va.

Scales: { Horizontal, 1 inch to 1 mile.
Vertical, 1 inch to 2,000 feet.

texture is often so finely granular and the color such a clear red, that it has been employed as a rude coloring substance, and hence popularly known as "dye-stone ore." These ores are usually imbedded in shales either interstratified with or overlying the sandstones, and are co-extensive with the formations in which they occur throughout this and the adjoining States. Their chief developments within reach of the R. & A. are (*a*) in the Purgatory range; (*b*) in Crawford's or North Mountain, near Eagle Rock; and (*c*) in the Rich Patch range, still farther west.

Of these three localities we shall notice first the Purgatory beds, which possess more than ordinary interest on account of their geological position, the abundance and richness of their ores, and their convenient position for mining and transportation. These points will be best illustrated by the following section and table of analyses taken from my report on this region, as published in "The Virginias," Staunton, October, 1880.

On examination of this geological section, we find at the bottom the heavy limestone strata of the valley (3 *b*, *c*) lying beneath the more fissile limestones of 4 *a*, and these again underlying the shales and shaly sandstones of 4 *b*, *c*, with their single bed of iron ore cropping out on the eastern face of Purgatory. The mountain is capped with the ponderous sandstones of 5 *a* (IV. R.), which pass beneath the valley between the two mountains, and again come into view on May's Mountain, forming a beautiful series of arches, where the ridge is cut by Roaring Run, not unlike those displayed at Clifton Forge, though not so extensive. This remarkable geological structure of these ridges, with the iron-bearing shales and sandstones of 5 *b*, *c* on their flanks, accounts very clearly for the extensive developments of ores along their spurs and foothills.

The quality of these ores has been tested in both the laboratory and the furnace. I analyzed samples from three openings remote from one another, with reference to iron, phosphorus, and sulphur, with the following results:

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| Metallic iron | 54.850 | 56.550 | 41.800 |
| Phosphorus | 0.085 | 0.112 | 0.094 |
| Sulphur | a trace | a trace | a trace |

Besides the oxygen and combined water, the foreign matter is chiefly clay, with a small percentage of lime and silica. The ores are, moreover, sufficiently soft and vesicular to be reduced in the furnace with great facility. It is not surprising, therefore, that, when formerly smelted in the Etna and Retreat furnaces, they produced a quality of iron which, as I am credibly informed, ranked very high in the Richmond market.

These beds are in the midst of a virgin forest that will supply fuel enough to run a charcoal furnace for years. And limestones suitable for fluxing are near at hand in very great abundance. Then for utilizing all these resources there is a fine site for a furnace and manufacturing village on the banks of the James at the mouth of Roaring Run.*

The Salisbury furnace is supplied with ores obtained near the western base of the Purgatory range, and is operating with decided success in the manufacture of charcoal pig-iron.

Up the river toward Eagle Rock is another development of ore of Clinton age (5 *c*), on the western slope of Crawford's Mountain, the prolongation of North Mountain.

On the land of Messrs. Rule and Sheets, about half a mile from the railroad line, a bank was opened some years ago, and worked for a while to supply the Salisbury furnace, a few miles lower down the river. The bed, as opened at that time, was about 12 feet thick and easily mined. So far as this ore has been tried it is said to make iron of good quality.

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* Some confusion may be avoided by noting that this is only one of *three streams* in Botetourt County, each called "Roaring Run." Of the other two, one empties into the James at Rocky Point Mill, and the other is a branch of Craig's Creek, running down from Rich Patch valley.

"Red shale" and "fossil" ores of this group are mined at Iron Gate (Clifton Forge), where they are found imbedded in shales between the heavy beds of sandstones that constitute the arched strata of Rich Patch Mountain where it is cut by the river. They are shipped to Quinnimont furnace to be used with the harder ores of 8 (VII. R.). The same ores have also been found at several points along the south-east slope of Rich Patch Mountain; and at the Roaring Run furnace, near Craig's Creek, they were employed for some years in mixture with the more silicious ores of No. 8 (VII. R.), the result being an iron of high grade. They have also been opened on the north-west slopes of Rich Patch in Alleghany, as will be noted in the more full discussion of the ore-beds of that region.

*Analyses* of seven samples of red shale and fossil ores from different localities gave a range of percentage of metallic iron from 38.71 to 57.12, with an average of 49.45; a range of phosphorus from 0.14 to 0.98, with an average of 0.38. They contained large percentages of clay and but little sand. The three samples of ore from the Purgatory banks are not included among those here given.

*Oriskany Epoch*, 8 (VII. R.).—Immediately overlying the group of sandstones and their accompanying shales and ore-beds, as just described, are extensive strata of Helderberg limestones (VI. R.) that separate them from the next higher formation, known as the "Oriskany," or VII. of Prof. Rogers' reports. Of all the ore-bearing formations in Virginia, at least of those in the Appalachian range, this is the most remarkable for the quantity of limonite ore that it contains, and for the facility with which it can be mined. It therefore merits special attention, as one of the most important factors in estimating the resources developed, and to be developed, along the line of the R. & A. R. R.

In order to appreciate fully its importance as a future source of traffic to this great line of transportation, it must be viewed, 1st, as to its topographical and geological relations; 2d, as to what its present developments indicate; and 3d, as to the quality of its ores. These points will be fully illustrated by a brief review of the two most important areas intersected by the road as at present constructed; and to be still further traversed by its future extension, whether this be along the valley of Craig's Creek or of Potts' Creek.

The first of these areas is in the mountain valley crossed by the railroad between Eagle Rock and

Iron Gate. On the south-east side it is bounded by the North Mountain and its prolongations, called Crawford's and Caldwell's mountains at Eagle Rock, then North Mountain again still farther to the south-east. Its north-western boundary is Mill Mountain in Rockbridge and part of Alleghany County ; then Rich Patch for 15 miles south-east of Iron Gate, and Potts' or Middle Mountain from that point to the head-waters of Craig's Creek. Between these two general boundaries we have a somewhat broken valley, and in some portions subdivided longitudinally by ranges subordinate to the principal ranges. Viewed lengthwise it may be regarded as beginning at Buffalo Gap in Augusta County and extending entirely across portions of Rockbridge, Alleghany, and Botetourt, and through the whole length of Craig's Creek valley several miles above Newcastle—an aggregate distance of about 75 miles. Its width varies from 6 to 10 miles. It is divided lengthwise by Bratton's and Brushy Mountains in Rockbridge, and by a continuation of Brushy Mountain and Anthony's Knobs in Alleghany, and by Barber's Ridge and other subordinate ridges in Botetourt and Craig counties.

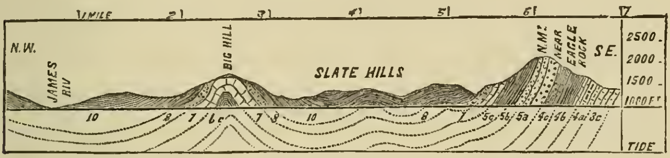
The portions of this valley that are of interest to the R. & A. road lie in Alleghany, Botetourt, and Craig counties. The Alleghany portion is drained chiefly by Simpson's Creek, a branch of Cow-pasture River, and the Botetourt and Craig portions by Craig's Creek, which enters the James at Eagle Rock. These features are important as showing descending grades for the transportation of ores and other products toward the railroad from both sides, through regions rich in mineral resources and timber.

*Geologically* considered this long area is a great synclinal trough, rendered double throughout a considerable part of its length by having portions of its bottom thrust upward by the elevation of the several subordinate ridges mentioned above. This will be more clearly understood by reference to Section No. V., p. 67. We may regard the bottom layers of this trough as composed of the heavy sandstones that crop out on its eastern border at Eagle Rock, and on its western border at Iron Gate. Next above these sandstones lie the ferriferous shales of 5 *c* (V. R.) cropping out high up along the faces of both North and Rich Patch mountains. Then overlying these shales come the very fossiliferous ledges of Helderberg limestones of No. 7 (VI. R.). Immediately over the limestone formation, and coextensive with it, is the Oriskany No. 8 (VII. R.), already mentioned as remarkably rich in iron ores. On top of this lie the vast masses of dark Devonian shales, No. 10, *a*, *b*, *c* (VIII. R.), that have been sculptured by the erosive action of water and frost into rounded and peaked ridges of almost every size, and found in almost every part of the region in question. Much of the picturesque scenery along this part of the railroad, and higher up Jackson River toward Covington, is due to the great number and variety of the slaty hills of this Devonian formation. They are interesting, moreover, as the source from which flow the waters of many well-known mineral springs, of which the Rockbridge, Alum, and Dibrell's may be mentioned as examples. These shales sometimes carry thin beds of limonite ores, but I have seen none in this region worthy of notice. Many persons have dug into these dark slates with the expectation of finding coal, very thin seams of which have sometimes been found, but none that could ever pay for mining.

The intermediate ridges already mentioned as protruding upward along the bottom of this trough-like valley are very important geological features, because they have brought up with them, and now hold upon their flanks, extensive beds of both ores and limestones for the supply of furnaces; for example, the ores that supplied California and Australia furnaces in past times, and that supply Longdale at present, were brought within reach of the miner by the uplift of Brushy Mountain.

*Big Hill*, which is cut by the railroad at Price's Bluff a few miles below Iron Gate, is one of the smaller of these subordinate ridges, but it is composed almost entirely of an arched fold, or wave-like wrinkle, of the two most important formations of this region—the Helderberg limestones, which form the arched "bluff" on the margin of the railroad track, and the *Oriskany sandstones*, that carry rich beds of limonite ores along the slopes of the ridge.

Section No. V.



Continuation of Section through Low Moor Mines,
Prolonged to Eagle Rock, Botetourt Co.

The accompanying section, No. V., conceived as cutting all the formations of this valley along the line I K, will aid the reader in comprehending the true relations of the ores and limestones to the other rocky beds, and forming in his mind a due appreciation of the extent of mineral wealth found here.

Although the Oriskany (VII. R.) is the most important of the ore-bearing formations in the region under consideration, it must not be inferred from what has been said that every part of it, or even the greater part of it, is iron ore. Large portions consist of a coarse gray sandstone that is frequently highly colored with iron-rust, and that breaks up readily when exposed, and weathers into rounded boulders of a brown color, as may be seen at points along the bases of almost any of the ridges in which it occurs. Still it is very persistent as an ore-bearing formation along the flanks and spurs of all the higher sandstone ridges of this region, and is almost invariably accompanied by the contiguous limestones, either cropping out between it and the mountain or so disintegrated as to be hidden by the débris of the more durable sandstones, in which case it usually forms a "bench" on the spur in which it is imbedded. The ore-beds of this region are often very massive. The ore exposed in the Longdale mines is about 20 feet thick, while its length and depth have not been determined. At Callie furnace, located on the slope of Rich Patch, about two miles south-west of Iron Gate, the ore-bearing strata range from 20 to 50 feet in thickness, consisting of alternating beds of sandstone and clay with heavy beds of ore.

*Resources.*—To illustrate in a general way the resources of this remarkable valley, it is only necessary to enumerate the furnaces that either have been in times past or are at present supplied from its banks of ore. In Rockbridge, the Bath, Mt. Hope, and California furnaces were of the olden time; and now the Victoria, destined to be the largest furnace in Virginia, is in process of construction, and is to be supplied chiefly from the old California banks, which give no evidence of exhaustion. Then in Alleghany was the Australia, and now the two furnaces at Longdale; in Botetourt, the Rebecca, Callie, Roaring Run, and Grace furnaces have, in many years, made comparatively little impression on the extensive beds from which they have taken their supplies of ore. But the limit of the present review is the area in which the R. & A. R. R. is now, or is likely to become, interested as a source of commercial traffic. This will include the counties of Alleghany, Botetourt, and Craig only.

In Alleghany the demonstrated value and extent of ore deposits within the area now under consideration is found in the Longdale mines, but abundant surface indications are found at other points along the spurs of the mountains on both sides of the valley.

Botetourt lies along both sides of the river and railroad in this section, and has its ore-bearing strata cut transversely at several points, as at Eagle Rock, Big Hill, and Iron Gate. Developments enough have been made to show great deposits of ore. At the Rebecca furnace near Dibrell's Springs the ore-banks have only been fairly opened, without any visible approach to being exhausted. These are within convenient distance of the railroad by a descending grade. The spurs of Anthony's Knobs are represented as carrying promising beds not yet developed. Big Hill is skirted by a promising vein that has been mined to some extent, and its products shipped to other points for smelting. But on the south-west side of the river the greatest openings and outcrops are found along the south-east flank of Rich Patch Mountain. These may be seen on the Kayser property at Iron Gate; the Callie furnace banks, already mentioned; the lands of Capt. D. S. Cook, where work is now progressing; on the property of the Alleghany Coal and Iron Co.; and at Roaring Run and Grace furnaces. Short lateral branches of railway could reach all these points, which vary in distance from 1 to 5 miles from the main line; except Grace furnace, which is near the line of Craig County.

This same fine belt of ore-bearing strata extends along the middle and western portions of Craig County, where the extent and richness of the ores have been so fully demonstrated as to warrant the conclusion that both the Clinton and Oriskany formations will yield, at no distant day, abundant harvests to the railroad company and the capitalists that may provide the means for developing their vast stores of wealth.

Of this region Maj. Hotchkiss says: "Often a solid bed of ore, 12 feet or more thick, containing as a mass 50 per cent or more of metallic iron, rests immediately on a limestone bed of No. VI. that will furnish the best of flux for this ore in the blast-furnace; while, beneath that VI., in the gorges and on the slopes of the same ridges outcrop the *red shale* and *fossil ores* of V., a yard in thickness, that are so desirable for mixing with those of VII. to produce the best grades of iron." ("The Virginias," June, 1880, p. 109.)

*Rich Patch Mountain Region.*—The survey we have taken of the valley just passed over has already brought us within the borders of the other area, alluded to a little farther back. It is the Rich Patch Mountain Region, on the geology and mineral resources of which I prepared a special report for "The Virginias," which was published in that journal, December, 1880. The main points discussed in that report, condensed within as small a space as is consistent with clearness, will, I think, constitute the best presentation that can be made of the value and importance of this region. For a more full discussion of its interesting features, the reader is referred to the journal in which it first appeared.

*Topography.*—This mountain-chain lies partly in Botetourt and partly in Alleghany county. At its north-eastern extremity it is a single ridge, cut by Jackson River, the main head branch of the James, so as to leave about a mile of its length, called Wilson's Hill, on the north-east side of the river at Iron Gate Pass. Toward the south-west, at a distance of about two miles, the ridge becomes a broad depressed arch; and still farther on the middle part of the arch has disappeared, and left a long uplift of the Silurian limestones uncovered, so as to form the bottom of Rich Patch valley, and give it a fine fertile soil, now cultivated by a prosperous agricultural population. The mountain thus becomes double, and the intervening valley continues to widen for about twelve miles from its beginning, until it is abruptly terminated at the base of Nicholas Knob, a lofty peak of more than 3000 feet, that forms the north-east end of Pott's or Middle Mountain. The Rich Patch valley belongs to Alleghany County.

That portion of the range forming the south-east border of the valley is quite continuous, and is known as Rich Patch Mountain throughout its whole length, till it is merged into Pott's Mountain. Its sandstones that form the crest, and strata, both above and below, dip almost uniformly to the south-east, as seen on Sec. No. VII. p. 76. The portion along the north-west border is more broken, and different divisions of it have local names, but for the sake of convenience we shall designate the former part of the range as "East Rich Patch," and the latter as "West Rich Patch Mountain." Along the outer flanks of these two main divisions of the range there are some special modifications worthy of note, and that are of great service in prospecting for ores and limestones.

Along the south-east slope of East Rich Patch the denuding agencies that have shaped its present features have in some parts cut deep ravines, that begin at considerable heights on the face of the mountain, and terminate far out among the foot-hills and slopes that flank its base. Several of these ravines carry streams that can be utilized in mining. Between the ravines we find a range of knobs high up on the face of the main ridge, and extending for miles along its general course. These are the outcroppings of the more fragile sandstones of 5 *b*, *c*, the still higher parts of which have been worn away. Among these are found the beds of fossil ores. Still lower down the slope is a range of "benches," formed by the disintegration of the ledges of Helderberg limestone, behind the more resisting ledges of Oriskany sandstone and its heavy beds of limonite ores. These benches begin to be conspicuous near the Callie furnace, and will serve as valuable guides to the explorer, not only here, but in almost all mountain-ranges where the Oriskany ores and Helderberg limestones are found.

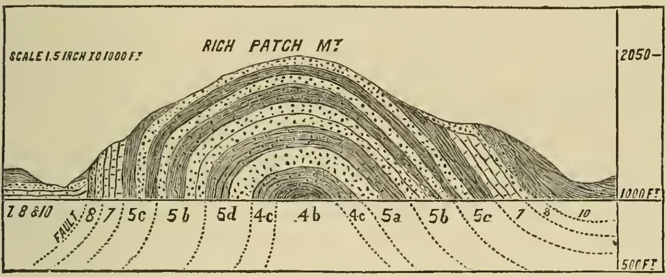
The north-west slope of West Rich Patch has features very analogous to those given for the eastern ridge as far as Low Moor furnace, except that the strata dip toward the north-west, as they are seen on Sec. No. VII. p. 76.

At Low Moor a new geological feature arises in this portion of the chain in the form of "Horse Mountain," which is a subordinate ridge formed by the upward bending of the sandstone strata, so as to leave a trough-like valley between it and the main ridge. This outlying ridge—though divided by streams of water into several parts called by local names—extends for several miles beyond Covington, the county-seat of Alleghany. The geological section, No. VII. p. 76, will show the relation of the ridges to one another.

The Rich Patch region is well watered, much more so than mountain ranges generally are, while its numerous streams are favorably situated to be utilized in mining operations.

*Geology.*—The arched section at Iron Gate (Clifton Forge) shows all the formations of this region above the Silurian limestones, in their simplest relations to each other, and very much as we had them in the Purgatory section, No. IV. p. 58. This is nothing more than a copy of what the forces of nature have brought to light in the magnificent gorge at Iron Gate. Near the entrance and exit of the river, some of the strata that help to form the abutments of the arch have been partially cut away, but have been restored on the section, because their representatives are near at hand on both sides of the mountain.

Section No. VI.

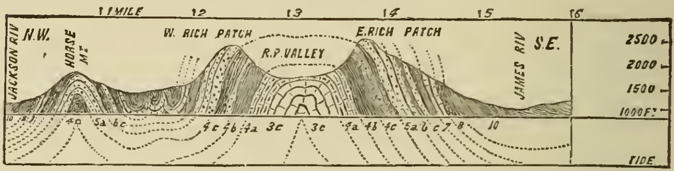


Profile Section at Clifton Forge on R. & A. R. R.

The subdivisions of this section correspond with those of Sec. No. IV. p. 58.

If we now assume a plane of section cutting the whole chain of mountains near the Low Moor mines, it will serve as a good typical representative of the geological structure of the first 12 miles of the distance north-west of the point of bifurcation of the main ridge. The reader is supposed to face north-westward; then on the left we have the great undulation in the sandstone strata called "Horse Mountain." This is an important feature, as it represents a long belt of ore-beds carried for many miles on its spurs. The complex trough at the Low Moor mines becomes a simple trough as it stretches toward the south-west, but carries its ore-beds with it, except at one short interruption, where the Covington and Fincastle Turnpike crosses it.

Section No. VII.



Section through Low Moor Mines and across Rich Patch Mt.

The red shale and fossil ores of 5 *b*, *c*, have been mined to some extent at Low Moor, but at the time of my last visit there no furnace test of their value had been made.

It will be seen that one extremity of the section cuts Jackson River on the north-west side of the mountain-range, while the other cuts the James on the south-east side. The line of section is marked N—O on the map. When the R. & A. R. R. has been extended up the Jackson River, the section will cut it at two points, about 15 miles from each other; the road through that distance closely bordering two sides and one end of this remarkable iron-field. But this is not all. If the road should continue its line up the valley of Pott's Creek, it will still be on the borders of the north-west belt, which is said to give decided evidence of continued richness for many miles along the skirts of Pott's Mountain.

*Resources.*—The abundant stores of ore and limestone in this region will be readily inferred from what has already been said and from what is displayed in the geological sections given above. They point to a continuous belt of the ores of 8 (VII. R.) of great extent, cropping out all along the south-east flank of Rich Patch, on the lands of D. A. Kayser, Esq., of the Callie Furnace Company, of Capt. D. S. Cook, of the Alleghany Coal and Iron Company; of the Roaring Run furnace; and throughout the greater part of Craig County.

Then on the north-west face of the range, the same bed of 8 (VII. R.), tripled by the elevation of Horse Mountain and its prolongations, presents a still more extensive display of ores. These were largely mined nearly opposite Williamson to supply the old Clifton furnace, now demolished. From the same belt Low Moor gets its supplies ; and still farther to the south-west, on the lands of H. Robertson & Co., explorations already demonstrate the existence of ores in great abundance. Beyond this property I have traced the same leads through the tract of A. A. Low, Esq., as far as Blue Spring Run—a tributary of Pott's Creek—about 18 miles from Iron Gate.

There are also along this face of the range several openings in the fossil and red shale ores, that indicate their presence in quantities that will, at no distant day, make them objects of value to the manufacturers of iron.

Thus I have endeavored to give but a brief sketch of this remarkable field of ores. Enough has been stated, however, to show how important it is to the interests of the R. & A. R. R.; and to show, moreover, that there are few, if any, sections of the Appalachian range more inviting to capitalists who desire to invest in the iron business.

The large bodies of timber found here will be more fully described under the general head of "Timber."

## The Limestones.

The extent and importance of the developments of limestone along this line will be most clearly understood and most fully appreciated if they are viewed under their several natural subdivisions. We shall call these the "James River Section," the "Great Valley Section," and the "Appalachian Section," each of which belongs to its own geological age, has its own topographical features, and its own mineral peculiarities.

1. The "James River Section" is interesting and important whether we take a scientific or a utilitarian view of it,—whether we look at its topography and geology, or at its past and potential utility in the arts. It has already been mentioned in connection with the iron-ores of the same region.

*Topographically* it is a comparatively narrow belt of limestone ledges running north-east and south-west, and probably coextensive with the State, though concealed from view at many points. It has been traced through the south-eastern border of Albemarle County, from the neighborhood of Gordonsville on the C. & O. R. R. to a point a little west of Howardsville, and near the R. & A. R. R. In the immediate vicinity of the village it is covered up by the Mesozoic rocks, a patch of which occurs here, where its peculiar coarse conglomerates may be seen in the village, and along the banks of the river for several miles above and below.

At this point the limestone first becomes an object of interest in our present discussion. Its occurrence in this neighborhood is well displayed at the old "Limestone Bridge," by which the Rockfish River was formerly crossed a short distance above its mouth, on the road leading from Howardsville to Warminster. Between this place and the great bend of the James at Mt. Athos below Lynchburg, a distance of 50 miles by the railroad, its outcroppings are numerous and extensively exposed along the river cliffs and in cuts of the railroad line; also along the ravines traversed by smaller streams on both sides of the river. In such localities the limestone strata, and those of the accompanying rocks, are frequently cut transversely by gorges of considerable depth, by which they are frequently exposed to view.

At the great bend the course of the river valley changes to the north-west, and passes out of the limestone belt, which continues its course toward the south-east, till it reaches the borders of North Carolina. But the section between Howardsville and the south-east end of Mt. Athos—literally the

James River Section—is all that claims any further notice at present.

These limestones are real metamorphic rocks, and are generally accompanied by mica and hydro-mica slates—the micaceous minerals sometimes interstratified, and sometimes mingled with the calcareous rocks. Serpentine is found mingled with the material of the crystalline limestone in some places, in such abundance as to make it a genuine "serpentine marble."

The strata that immediately bound the limestones are sometimes hard and durable mica schists; but the great dividing ledges are quartzites and chloritic slates. These hard rocks—the most durable of the region—form the backbones of nearly all the high parallel ridges that rise on both sides of the river. The calcareous rocks and the mica slates, yielding more readily to the weather, are usually found on the slopes of the hills or in the intervening valleys. Refer back to geological section No. I., p. 38.

The *geological age* of this long narrow area has not been fully settled. But the more frequently I look into it, and the more frequently I examine the rocky beds that bound its margins, the more I am inclined to regard it as synchronous with the Huronian division of Archean time, as defined in regions farther north.

*Lithologically* it has several features that define its limits with considerable precision, and that distinguish it from all other subdivisions of the metamorphic rocks of Piedmont and Middle Virginia. Although it has been subjected to a considerable degree of metamorphism, the action has not been so strong nor so uniform as in most parts of the surrounding region. Several of its ore-beds have so far escaped the metamorphic action of heat as to retain their hydrated condition. While in some places the limestones have been changed to white crystalline marble, there are other places where the bedding and even the lamination has not been so much affected as to indicate the operation of causes sufficient to obliterate the harder parts of fossils, such as the cells of coral and the shells of mollusks, if these had ever existed, imbedded in them. Such facts seem to me to point to the conclusion that, while these are older than any that are recognized as real fossil rocks in Virginia, they are more recent than the great mass of metamorphic rocks of this portion of the State, but older than the Lower Silurian limestones of the Great Valley.

The practical value of this range of lime-bearing rocks has been fully demonstrated for many years, in the several uses to which they have been applied: (*a*) as building stone; (*b*) in the manufacture of lime for agricultural and architectural purposes; (*c*) for fluxing in blast-furnaces. For building purposes these rocks are easily quarried in the form of slabs that are readily shaped to suit for walls of any desired thickness, as may be seen in the foundations and chimneys of old houses along the river valley, and in the masonry about the locks formerly used on the canal. These applications have fully tested their durability. For lime they have been burnt successfully on a small scale at many points, a few of which will be given by way of illustration. (1) On a place formerly belonging to Dr. Peters, between Warminster and Norwood, but a little off from the river. (2) Near the north-west base of Drummond or Mine Ridge, near the Greenway mines, a stone of compact granular structure is found, from which lime of good quality is said to have been manufactured. (3) Close to the margin of the railroad, near Walker's Ford, considerable quantities of lime were burnt in former years. (4) On Stonewall Creek, about two miles from its mouth, several large kilns were in operation two years ago making lime for the general market. These are examples enough to show that these beds are worthy of attention as sources of lime; but the problem as to whether or not this lime can compete in market with lime from Rockbridge and Botetourt counties awaits demonstration.

For *furnace flux* limestone has been quarried from beds about 2 miles below Warminster. From this place the Dean furnace, at New Canton, was formerly supplied. The furnace on Elk Creek was supplied with limestone from the immediate vicinity during the whole time of its operations. The Stonewall furnace in Appomattox County employed the limestone from the neighborhood, and found it satisfactory. At the present time fluxing material is furnished for the Lynchburg furnace from the neighborhood of Mt. Athos. Hon. A. L. Williams says of a bed of limestone near the base of Mt. Athos, and near the R. & A. R. R: "It is about 300 feet thick, a solid and compact stone from which I have mined several thousand tons for use as flux in the Lynchburg furnace, where it gives good satisfaction. It yields on analysis about 92 per centum of carbonate of lime."

These examples are sufficient to show that furnaces hereafter erected along this great river valley can obtain an indefinite quantity of limestone of a quality suitable for fluxing, at very moderate cost.

II. "The Great Valley," lying between the Blue Ridge and the North Mountain, is emphatically the limestone region of Virginia. Both branches of the R. & A. R. R. enter this region soon after their separation at the junction of James and North rivers. Here almost every variety of limestone is found in immense quantities: the hydraulic, from which cement has been manufactured for many years at Balcony Falls; the blue compact variety, successfully burnt for lime in many places; the fine gray crystallized, coralline variety, from which lime of superior quality is made in both Botetourt and Rockbridge; some beds from which a pretty variegated marble is prepared; then the soft calcareous tufa or marl, accumulated along many of the limestone streams, besides other varieties less worthy of note, indicate that the supply of limestone in the region, for almost every purpose to which it can be applied, is practically unlimited.

The two special applications that most concern our present discussion are in the manufacture of lime, hydraulic and architectural, and as flux for furnaces. The hydraulic limestone is found low down in the series, 3 *a* on section No. II., and has been obtained of good quality from two bands, the one interstratified with shales near the lowest limit of the limestone series of the valley, the other a little higher up among the beds of tolerably pure light-blue rock. The former of these beds has supplied the kilns at Balcony Falls for many years, and the cement made there was extensively employed in building the dams and locks on the canal; the latter bed also furnished, for use on the canal, large quantities of cement manufactured on the banks of North River, a few miles below Lexington. This variety of limestone is found at numerous points and in great abundance along both branches of the railroad.

The fine architectural lime now made at Col. Dillon's kilns in Botetourt, and by Messrs. Alexander & Irvine near Lexington, is from a beautiful gray coralline limestone found in large quantities, as already stated, in both Rockbridge and Botetourt. It is geologically the lowest bed of the Trenton period, and consists of the finely comminuted cells of an ancient coral-reef, cemented together by the infiltration of carbonate of lime from limestone waters, giving the whole mass a compact crystalline structure. Its chief localities are, first, in the immediate vicinity of Lexington, where an extensive ledge of it skirts the south-east base of the Brushy Hills, and crosses North River about one mile above the railroad bridge. Fine exhibitions of its quality as a building-stone may be seen in the Grace Episcopal Church, and in the foundation of the buildings of Washington and Lee University and of the V. M. Institute. Although this formation in the vicinity of Lexington is 150 feet thick, it is not all of first quality for either building-stone or lime. Some of the beds contain numerous shells that disintegrate when exposed to the weather, and make only a second-grade stone for either building or making lime. But this is easily separated from the higher quality, and can be utilized as second-grade material. A second locality is near the main stem of the railroad, beginning a short distance west of the Natural Bridge. A narrow detached ledge of this rock once connected with the beds that underlie Purgatory Mountain has been tilted over toward the river, and now abuts against a mass of the much older hydraulic limestone, brought up to the same level by a fault, or slip, of several miles in length. It has been traced from Springfield, a short distance west of Natural Bridge, along the river hills as far as Dillon's limekilns near Indian Rock. A fine exposure of it may be seen where crossed by Roaring Run half a mile from its mouth at Rocky Point mill on the James.

A third locality is near Eagle Rock, at the southeast base of the mountain. It is geologically the same stratum as that found at the two localities above mentioned. An outcrop is conspicuous between the railroad and the residence of the late Adam Rule. It is also largely displayed on the west side of the river, nearly opposite Eagle Rock station, on a tract belonging to the estate of the late Dr. A. Graham, of Lexington. At this place its value for lime has been demonstrated by repeated trials.

The tests that have been made of this variety of limestone for furnace flux are said to have been most satisfactory. Samples that I have tested contain from 90 to 96 per centum of carbonate of lime. The facility with which this stone can be quarried at all of the localities named above, especially in the neighborhood of Lexington; its beauty as a building-stone, equal to that of the finest granite; the quality of the lime it produces, and its superior adaptation for use in the blast-furnace, entitle it to a high position among the mineral resources along this line of railway.

Other varieties of limestone abound in all parts of this valley section to such an extent that it would be difficult to go amiss in seeking for them. They are generally more or less magnesian, but not to such an extent as to seriously impair their value for making lime or for use in the furnace. Where they have not been crushed by geological disturbances, many of their beds can be quarried in slabs of moderate thickness and of almost any desired size. Such is the case at the Natural Bridge and at conspicuous points along North River.

III. The Appalachian limestones have been already mentioned so frequently, and their position with reference to the iron-ores so fully stated, that very little more is wanted to give a full view of their extent and importance. They are known as the Lower Helderberg of New York, No. VI. of the Professors Rogers, and No. 7 of the general American system of notation. While they always accompany the ore-deposits of 8 (VII. R.) in this part of the Appalachians, they are far more continuous than the ores, and are hence found in abundance at many points where the ores seem to be wanting. They are exposed, as heretofore stated, at several points between Eagle Rock and Clifton Forge, at both extremities of the river gorge at Iron Gate, near Longdale furnace, and at several places along the C. & O. R. R. between Williamson and Alleghany stations. They are also abundant along the valley of Pott's Creek.

The value of the limestones of this age for furnace use has been proved by the great extent to which they have been, and are still, employed at Longdale, Callie, and Low Moor.

In this formation some of the strata are highly fossiliferous, being made up largely of crenoids and shells of different species; and when sufficiently compact take a good polish and make a variegated marble that is both unique and beautiful. This marble has been quarried in large quantities near Craigsville, Augusta County, and there is good reason to believe that it may also be found in Rockbridge, Botetourt, Bath, Alleghany, and other Appalachian counties.

FUEL.—Next to the almost incalculable supplies of ores and limestones that have been brought under review, the question of fuel naturally presents itself. The subordinate questions of kind must be decided by the objects to be attained. But whatever the objects may be—whether charcoal, mineral coal, or coke is demanded—an abundant supply is readily available.

*Charcoal* has by no means served its day as fuel for reducing iron from its ores. Improved methods of applying coal and coke will have to be introduced before the iron smelted by them can rank with the tough charcoal-iron for many purposes of art. Whatever of profit may still be found in the use of this class of fuel is certainly within easy reach of many who own, or who may purchase, ore-lands along the James River valley.

Extensive tracts of virgin forest are found in Buckingham, sufficient to yield charcoal enough to reduce many thousands of tons of metal from the ores that abound in the same region. The same may be said of Appomattox, Nelson, Amherst, and Bedford. In the two counties last named very extensive bodies of timber cover the south-eastern slopes and foot-hills of the Blue Ridge, and could be readily utilized for working up mixed ores collected from Rockbridge and Botetourt, above the mountain, and from the counties bordering on the James below.

On the north-western slopes of the Blue Ridge, from Balcony Falls to White's Gap, opposite Lexington in the one direction and to Cloverdale, of Botetourt, in the other, right along the great ore-belt, extensive forests also await the capital and enterprise of those who desire to embark in the manufacture of charcoal-iron at a minimum cost.

The Rich Patch range has also wide areas of virgin forest covering and surrounding its ample beds of rich limonite ores, which together with the large quantities of charcoal that can be burned here would be easily carried to eligible furnace sites convenient to both water and transportation.

Timber for Other Uses.—From these forest lands an indefinite number of railroad ties, of superior quality, can be obtained at points not very remote from one another, and therefore easily distributed along the line when wanted; or they can be conveniently shipped to other lines whenever and wherever a demand for them may arise.

Young chestnut-trees suitable for telegraph-poles grow in great numbers along both slopes of the Blue Ridge, especially in the old coaling grounds along the western flank of the Ridge, contiguous to the charcoal-furnaces once operated in that region.

Tan-bark is another article of increasing commercial importance that may be gathered in great quantities from the millions of chestnut-oak-trees found growing in the forests of every county bordering on this valley.

The forests of Buckingham have already become a source of large revenue to that venerable county, and there is every reason to believe that with the forest products of the kinds above indicated, and others in the form of lumber for constructions of all sorts, such as buildings, machinery, and furniture, an active trade will ere long arise that will become a source of profit to the railroad as well as to the whole belt of country through which it passes.

*Coal* and *coke* have no known limit to their supply for use along this line of railway. We may look to the Richmond coal-field at one extremity, and at the other to the New River and Kanawha fields now traversed by the C. & O., and soon to be penetrated by the extension of the R. & A. R. R.

The future of the Richmond field is regarded by many as very promising under the aid of improved machinery and more systematic methods of mining than have prevailed in past years. The coals from Chesterfield and Powhatan on the south, and Henrico and Goochland on the north side, have been long in use for working iron, as well as for domestic and for steam fuel. Good coke is also made from this coal; while carbonite, or native coke, found here in considerable quantities, is highly esteemed as fuel for any of the purposes to which artificial coke is applicable.

As far as my inquiries extended among the dealers in coal and the consumers of it in working iron, I could find no one prepared to answer the question whether or not the Richmond coal was likely in the long-run to compete successfully with the New River and Kanawha coals; whether short and easy transportation, with somewhat difficult and expensive mining, in the one case, and easy mining, with long and more expensive transportation, in the other, would be likely so nearly to balance the cost of putting these coals from these different fields on the market as to prevent ruinous competition on either side. This case presents a problem that future operations must solve. The fact that men of experience in mining coal are risking their capital in the purchase and reopening of old mines, and in the development of new ones, is the most favorable expression of opinion that can possibly be given in favor of the continued productiveness and profit of the Richmond field. As illustrating this fact, the "Henrico Coal Company" have recently constructed a line of railway six miles in length from their Deep Run mines in Henrico to Lorraine station on the R. & A. R. R.

In supplying furnaces with fuel from either the Richmond or the New River mines, the question arises between erecting furnaces near the fuel, and transporting the ores and limestones for a considerable distance, or erecting the furnaces contiguous to the ores and limestone, and transporting the fuel to the same point. Quinnimont furnace presents a case in which the former plan has been tried, while Low Moor and Longdale prefer to bring the fuel to the ore and limestone. The weight of argument from experience seems to be in favor of transporting the coal and coke to the ores—at least in cases where the ores and limestone are contiguous to each other. For all the various uses to which coal and coke are applied—whether in the furnace or the factory, whether on railroads or steamboats, or for domestic consumption — there will be an ever-growing demand, and hence a corresponding growth in their importance as articles of railroad traffic. But whatever proportions the demand may attain, the Kanawha valley will still afford an ample supply to meet it.

## FURNACE SITES.

It is certainly the true policy of the railroad, and of the mass of the people along the line, to give all possible encouragement to the erection of furnaces and such other manufacturing establishments as will inevitably follow in their train. It is to be hoped that the period of speculation in mineral lands along this line is drawing rapidly to a close, and that the period of real enterprise has dawned.

The shipping of the fine steel-ores from the James River belt may have served a good purpose as a means of making their high quality known, and of introducing them to enterprising manufacturers of iron and steel in other states, but that method of treating them gives only the minimum of benefit to the community, the railroad, and the State. A ton of ore shipped to Pennsylvania or Ohio leaves at most only two or three dollars in Virginia, while the same ton of ore worked up into commercial iron or steel on our own territory would have its value so much increased as to bring back from outside markets several times the value of the ore in its crude form, and thus become the reward of capital, skill, and labor operated upon our own soil. The revenues of both the railroad and the State, too, would be thus augmented.

Furnace sites are so numerous along the margin of the railroad all the way from the valley of Pott's Creek, in Alleghany, to the lower limits of Buckingham ; and the sources of water-power so extensive and so generally distributed, that it is useless to attempt their enumeration. The canal-dams are still standing between Richmond and Buchanan, on the main stem, and Lexington, on North River branch. Above Buchanan there is ample fall in the river for numerous additional dams if they should be wanted. The Longdale and Callie furnaces are within reach of this line and in active operation ; while the Salisbury furnace, above Buchanan, and the Amherst furnace, near Rope Ferry Bridge, have both been doing well for some time. The Glenwood furnace in Rockbridge, and the Arcadia in Botetourt, could be put in blast for making charcoal-iron at but little cost. The Lynchburg furnace is at work with energy and success.

## MANGANESE.

The peroxide of manganese is a mineral for which there is great demand when it can be found of requisite purity. In England, France, Germany, and to some extent in other countries it is consumed on a large scale in the preparation of "bleaching powder" and for other purposes of art. When sufficiently free of phosphorus and other impurities it is valued for the manufacture of ferro-manganese and articles employed in making Bessemer steel. The opening of the R. & A. R. R. has stimulated anew the search for this important mineral.

Several years ago a mine of manganese on the Cabell place near Warminster, Nelson County, was opened and operated for a while by Col. B. J. Jordan, of Rockbridge; but the work was for some cause suspended. I have recently ascertained that preparations are on foot for the re-opening of this mine, with the introduction of improved machinery. An analysis of a sample from the same mine, made by me several years ago, gave as the result 81.25 per centum of the peroxide—an unusually rich ore; but this may have been above an average specimen.

Manganese has also been discovered in the neighborhood of Norwood, but I saw none there that indicated very superior quality, though such may yet be found. The same mineral, of good quality, has been mined to some extent near Mount Athos, in Campbell County. In Rockbridge, on the Brady estate, some mining has been done; and on the Glenwood place a bed has been found, but not well opened, of which I analyzed a sample that gave me 74.15 per centum of peroxide, which is 4.15 above the market standard in England.

*Copper ores* have been found in Buckingham, near New Canton, and on the banks of Slate River, contiguous to the Lightfoot gold-mine. They have been opened, and work was going on when we visited the locality in the summer; but developments had not been carried far enough then to indicate with certainty their value.

The copper-belt lying along the north-west base of Buffalo Ridge, in Amherst and Nelson counties, was opened at a point near "The Folly," in Amherst, many years ago, but subsequently abandoned. The same mine has been re-opened recently, but the question whether it can be re-opened with profit or not remains to be demonstrated. At another point on the same lead, a few miles farther to the south-west, another mine has been opened that is regarded as promising. That portion of this copper-belt traversed by Tye River in Nelson, it is in convenient distance of the R. & A. R. R. at New Market, and gives evidence of rich copper-ore in that vicinity sufficient to make it an object of careful exploration. Copper-ore has also been found in the vicinity of Lynchburg, where the copper-belt appears to cross the river. The same ore occurs still farther to the south-west, but no conclusions can be reached as to its extent and character at these points until more extended explorations have been made.

## GOLD.

The "gold belt" of Virginia extends from its north-eastern limit, beyond the Rappahannock River, in a south-westerly direction, approximately parallel with the general trend of the Blue Ridge to the southern border of the State, where it passes into North Carolina. That portion in which we are now interested lies near the boundary between Goochland and Fluvanna, on the north side of the James, and in Buckingham, on the south side. Its average width where it is cut by the river and the railroad is about 12 miles. The rocks here belong to the Archæan age, and are gneissoid, schistose, and slaty in their general characteristics. Although originally horizontal in position, they have been subsequently elevated, faulted, and folded, till they are in many places nearly vertical, and everywhere dip steeply towards the north-west or south-east, most frequently in the latter direction; while their general trend is north-east and south-west, like the great majority of the rocks of this Piedmont country.

The gold is formed in quartz-rock, sometimes in distinct veins of considerable thickness, and at other times in the same material disseminated through masses of schistose and gneissoid rocks. The metal seems to have been originally carried by iron and copper pyrites, especially the former. Nearer the surface these sulphides have been decomposed by the long-continued action of water and air; the copper having been dissolved out, the iron partly dissolved and partly oxidized, and the metallic gold liberated in fragments of various shapes and sizes. By this process of long-continued weathering the vein matter was disintegrated and its fragments, with the débris of the imbedding rocks, were collected in depressions and along the margins of small streams, and thus gave rise to the "placer-mines," so long worked in this region. The great object was to separate from the mixed mass the free gold. The larger particles were obtained by washing out the lighter minerals, or by first stamping and then washing; and the more minute gold-dust was caught by amalgamation with mercury.

When the veins are penetrated to any considerable depth they are found to carry the gold in the sulphides (pyrites) so intimately associated that mechanical means alone are insufficient to separate the whole of the precious metal. Even stamping, roasting, and amalgamation all combined have been found to leave a large percentage of gold in the "tailings" untouched.

To secure this residue several chemical processes have been tried at different times, but that which just now promises the most satisfactory results is known as "Mears' Chlorinating Process," by which the stamped and roasted ores are subjected to the action of water saturated with *chlorine gas under high pressure*, which then has the power of dissolving out the fine particles of gold with great facility. From the solution thus obtained the metallic gold is precipitated as a brown powder by the addition of a solution of copperas (ferrous sulphate).

A considerable number of mines have been opened and worked at different times along this and other portions of the belt with varying degrees of success, but in the majority of cases with so little ultimate profit as to be finally abandoned.

But since new light has been thrown upon the real richness of these veins, and improved contrivances for mining and reducing gold-ores have been devised, new life has been infused into this branch of industry in Virginia, and mines long ago abandoned have been recently bought out by capitalists, and some of them already worked with profit, while others are being re-opened with the application of improved machinery for mining the ores and the new process of reducing the metal.

In Goochland, four miles from Columbia, what was once worked successfully under the name of " Bertha and Edith mine," chiefly as a placer-mine, and subsequently suspended, has been recently purchased by the "Tagus-Mill Mining Company," and is in process of re-development. The " Sneed mine," in Fluvanna County, a few miles north of Columbia, has improved machinery for mining, stamping, washing, etc. ; and when we visited the place preparations were in progress for erecting an improved " Mears' Chlorinating Apparatus." Other of the old mines of Goochland and Fluvanna have been purchased by capitalists, and are most probably in operation by this time ; among these the Stockton mine, once operated with large profit.

The mines in Buckingham have had their "ups and downs"—their days of prosperity and days of adversity,—but the belt in this county certainly has several rich veins. In some places they are hard quartz-veins, carrying both auriferous pyrites and free gold; in others the vein-stone has a honeycomb structure to a considerable depth, due to the sulphide of iron that carried the gold with it being decomposed and partially dissolved, while the particles of gold were left free in the residuary mass, accompanied by some of the iron left undissolved as hydrated oxide or brown hematite.

Considerable activity is manifested in this county, as well as in those on the north side of the river, either in opening old veins or in searching for new ones. The Lightfoot mine, near Slate River, and about 7 miles south-west of New Canton, was worked as recently as 1861, and was regarded as one of the best in the county. It will doubtless be re-opened under the stimulating influence of railroad communication along the river and through the county.

The Apperson mine, about 12 miles south-west of New Canton and 10 miles north-east of the Court-House, still promises good results from application of improved means of mining and reducing the ore. There are three veins in this vicinity. The first vein measures from 10 to 15 feet of gold-bearing rock, the metal being found in particles disseminated through the porous, silicious mass. The vein is about half a mile farther east and is a whiter quartz, but it had not been well opened. A third, still farther east, has the gold-bearing quartz disseminated in hard schistose rock like that of the Booker mine.

The Philadelphia mine, a mile or two south-west of the old Eldridge diggings, has been recently opened on a vein of about 4 feet, consisting of a porous silicious oxide of iron, with disseminated particles of gold. At a greater depth the iron will doubtless be found as auriferous pyrites, and the vein most probably increased in both width and richness.

The London and Virginia mine, in which a great amount of labor and capital lie buried, is said to have been in a deserted condition for 20 years; but plans are afoot for its resuscitation under the improved facilities that are applied successfully to other old mines long since supposed to have died a natural death. This mine is about 7 miles north-east of the Court-House, and not far from the road leading to New Canton.

I examined the "old Booker mine," now called the "Morrow mine," with some care. The "vein," as it is called, in which work was going on, is at least 30 feet wide, and is composed of a schistose rock with injected quartz, forming in some places secondary veins and thin sheets, and at other points apparently dispersed, with its accompanying auriferous pyrites, in the slaty beds of hard rock that make up the main mass of what is taken from the mine. It is what might be called a "dispersed vein." The operations here are said to have been very profitable for the last three years, during which the mine has been worked under the best modern appliances and with energetic management. This mine is about 9 miles south-east of the Court-House, and not far from what appears to be the limit of the gold-belt in that direction. Its gold is said to carry with it a considerable percentage of silver.

The Philadelphia and Willis Creek mines had not been fully opened when we last visited the county; but a letter from A. T. Mosely, Esq., dated Buckingham Court-House, October 27th, informs me that "the parties working them are much pleased with their prospects, both of them having good fissure veins from 5 to 8 feet wide. They are now putting up machinery at both of them, and I have not the least doubt but that they will turn out well." The Philadelphia mine is near the London and Virginia above mentioned, about 7 miles north-east of the Court-House and 9 or 10 miles from New

Canton. The Willis Creek mine is about 9 miles to the south-west of the Court-House, and is supposed to be on the same lead as the Philadelphia.

When railroad communication has been established through this remarkable mineral county—of which there is a pretty certain prospect now—additional capital will soon flow into it and new enterprises spring up, by which its vast stores of still hidden wealth will be rapidly developed. Its iron-ores, its copper, its gold, its slates, and its forests are only awaiting capital and transportation to make them the means of restoring this county to its former prosperity and renown.

## SLATES.

The fine roofing-slates of Buckingham are worthy of special consideration, as well on account of the quality as the quantity of the material there found. The belt of slate is on Hunt's Creek, a branch of Slate River. The quarries extend up this creek for several miles, with a trend practically parallel with Slate River and at a distance of from one to two miles east of it. The slates are intersected by numerous veins of igneous quartz, not unlike, in general appearance, the gold-bearing veins; and also by occasional trap-dikes, one of which crosses an old opening in the Nicholas quarry. The heat from these igneous rocks has doubtless been a very potent agency in giving the slates that highly indurated, metamorphic condition that renders them so durable, while a uniform lateral pressure acting at right angles to their planes of stratification, has given that peculiar structure which results in an easy and regular cleavage when fully quarried.

Some of these quarries have been worked for more than half a century. The principal ones are all that need to be named. What is known locally as "Perrow's Big Quarry," owned by Mr. J. M. Norvell and others at Bremo, is on Hunt's Creek, one mile east of Slate River and two miles from the James. A vast quantity of slate has been taken from this quarry, but when we visited the place it was suspended, on account of some conflict of claims. The Nicholas quarry, a little farther up the creek, is worked on a large scale by Messrs. J. R. Williams & Co., of Richmond, and shipped from Bremo by the R. and A. R. R. Messrs. Edwards & Robertson's quarry, in the same vicinity, is largely opened, very successfully operated, and its products shipped by the same route. The strata, or rather laminæ, of slate in all these quarries are nearly vertical and have a very uniform strike N. 25° E., which is about the average bearing of all the strata between Slate and Willis rivers.

At present nearly all the slate from these quarries is split and shaped for roofing purposes, except where special orders are to be filled for material to be applied in other ways. Its strength, durability, and uniformity of texture have given it a national reputation that will, for many years, make it a valuable source of profit to the owners and to the county in which the quarries are located, as well as an important article of freight on the railroad towards both Eastern and Western markets.

The same belt of slate appears on the north side of the James, on the Cocke estate, a short distance above Bremo station, but has not been opened to a sufficient depth to test its quality at that point.

Another belt of slate, apparently of the same geological associations and age as the one just described, lies near the south-east base of the Blue Ridge, in both Amherst and Bedford counties, cut through by the James River 4 miles below Balcony Falls. It is extensively exposed about 2 miles north-east of the river, where a Lynchburg company have opened a quarry that yields a slate of fine appearance and of finer grain than that of the Buckingham quarries. A small opening has also been made on the south-west side of the river, by the Alleghany Coal and Iron Company, sufficient to prove the existence of slate of good quality and to indicate the presence also of a large quantity. I have subjected samples from this belt to crucial tests, which they bore remarkably well.

There are a number of other points within reach of the railroad, at which slate of promising appearance crops out on the surface; but the true character of the material can be determined only by actual openings to such depth as will reach beyond the limits of long-continued weathering.

## GRANITE.

The quantity of granite is so great, and the points at which it can be quarried are so numerous, along this line of railway, that it will be impossible to give an adequate view of its extent and availability within the brief space to which I am limited. A few general statements must, therefore, dispose of this branch of my subject. The granites of Chesterfield and Henrico, that form the bottom and the bordering ledges and cliffs of the James at Richmond and for 8 or 10 miles above the city, are gneissoid in their structure to a considerable depth, but gradually pass into real *granite*, which was undoubtedly gneiss of sedimentary origin that has been subjected to such intense aqueo-igneous and other agencies as to have lost in a great measure its original structure and to have become thoroughly crystalline in its texture. The varying degrees of metamorphic action can be seen in almost any of the quarries that have been opened. The distinctly bedded gneiss, the more heavily bedded gneissoid granite, and then the more homogeneous masses of granite succeed one another, not abruptly as a general rule, but by a somewhat gradual transition as the quarry is deepened.

The erosive power of water, or more probably of water and ice combined, (perhaps at the breaking up of the "Glacial Period" of geological history), that opened the valley of the James, prepared the way for developing the fine quarries of granite that have been so successfully wrought in the vicinity of Richmond, on both sides of the river. There are still many localities extending as far up as the margin of the coal-field, at which new quarries could be easily opened.

No higher compliment could be paid this valuable building material than the demands for it that have come from the engineering department of the United States Government for a series of years. A like appreciation of its high qualities is shown at the present time by the Chamber of Commerce of Baltimore, in selecting it as the best material for the fine new hall they are now erecting.

Among the material shipped from the "Philadelphia quarry," as it is called, two quite distinct varieties are found, both very beautiful, but not alike adapted to all kinds of use. The one is a light gray of fine texture, having the crystals of feldspar small and of light color. This is a beautiful material for the smaller structures, pediments, etc., about a cemetery, and for the lighter kinds of architectural work, such as the window-sills of brick houses; but not, to my eye, well suited for walls, columns, or large structures of any kind. The other variety has larger crystals of feldspar of a light flesh-color, and more nearly approaches the Scotch granite in *texture*, though still much lighter in color. This is well adapted to make a pleasant impression on the eye when viewed in large masses, such as are presented in all heavy structures.

At Columbia, in the corner of Fluvanna County, about 56 miles above Richmond, a quarry of considerable width, but not much depth, was opened many years ago, to furnish material for masonry on the canal; but the quarrying was so very superficial that the real granite was never reached. It is in a good condition, however, for deeper work, by which stone of superior quality could no doubt be obtained at a moderate cost, and is remarkably well located for shipping on the railroad.*

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* Since the above was written this quarry has been re-opened.

Near Buckingham Court-House we visited an exposure of granite of the coarsely grained variety, of great beauty. It is so little obscured by overlying material that a considerable quarry could be at once opened with comparatively little preliminary stripping. The new railroad to be run through that county will no doubt bring this locality into favorable notice—provided the railway passes near enough for convenient and inexpensive shipment.

Some of the thick beds of *Syenitic Gneiss* exposed in the cliffs cut by the railroad between Lynchburg and the Blue Ridge are remarkably homogeneous in texture, beautifully crystalline in structure, and afford a "granite" easily quarried and shipped, and of great durability and beauty.

## OTHER MINERALS.

*Steatite*, or soapstone, sufficiently compact and homogeneous to be employed for lining stoves, fire-places, grates, and furnaces, is found in a belt lying near the north-west base of Buffalo Ridge in both Nelson and Amherst counties. It has been quarried to a limited extent at several points for local use, but has never been brought into general notice. It constitutes a portion of the rocks that carry the copper ores of Nelson and Amherst, and has been traced to the river above Lynchburg, and as far towards the south-west as the neighborhood of New London in Campbell and Bedford counties. A bed of the same material occurs in Cumberland County, on the land of Dr. Walton, near Cartersville, but has not been opened sufficiently to determine its quality or extent. The same may be said of some other localities. I have seen good specimens from Fluvanna, but I know of no open quarries.

*Mica* of good quality has been mined near Goochland Court-House, but the mining is said to have been abandoned on account of the influx of water. In Fluvanna and Nelson this mineral is found, but not developed. The same is true of Powhatan, Cumberland, Buckingham, Nelson, and Amherst. A little enterprise would probably develop valuable mines in some of these counties; but from what is now to be seen on the surface, I can assign no definite value to any of the localities that came under my observation.

*Kaolin* and *Fire-clay* of good quality are of frequent occurrence among the metamorphic rocks of this region, and have been opened to some extent near the line of the Midland R. R. in Nelson County, but I have not seen the locality. At Bon Air, 9 miles from Richmond, kaolin and ochre are mined in the same vicinity; the quality of the kaolin had not been fully tested, but seemed to promise favorably. Fire-clay on Dr. Dance's farm near Powhatan Court-House is very abundant, and is reported to have been subjected to decisive test. Similar clay is found in Cumberland, Buckingham, and Appomattox. On the White estate near the mouth of Bent Creek a clay of this class has been tested sufficiently to indicate a good quality.

The *fire-clay* that has been mined near the mouth of North River in Rockbridge has been regarded as of superior quality, from some tests to which it has been subjected in making fire-proof bricks. My impression is that it merits a more thorough trial; and that it would most probably be improved by mixture with some of the clays derived from the more distinctly metamorphic rocks, farther down the James River. The large quantity of fire-clay found contiguous to the belts of micaceous and talcose slates of Amherst and Bedford could be brought to the railroad at but little cost, and with the Rockbridge clay would undoubtedly make good fire-bricks.

When furnaces and other manufacturing establishments spring up at various points along the line of the road, the demand that will thus arise for fire-bricks will stimulate those who own the material to enter upon their manufacture; thus we may hope to see made within the State of Virginia at least enough to meet the home demand.

*Barytes* of fine quality is mined largely near one of the limestone ledges, in the prolongation of the James River belt in Pittsylvania County. It is ground in Lynchburg by Mr. John S. Morris, and shipped to eastern markets. The same mineral has been found in Rockbridge County near Brownsburg, and also in the neighborhood of Buffalo Mills, 5 miles south of Lexington. The quality in both of these localities is good, but the quantity is not yet determined. In Botetourt County, on the land of Mr. Booze, 2 miles north of Buchanan, some excellent surface specimens were found, but the bed from which they came has not been discovered. The quality of this also would justify more extended and careful explorations. This mineral differs but little in general appearance from gypsum, or crystallized limestone, but is so much heavier than either of these minerals as to make it easily distinguished by the difference of weight alone.

*White sand* has been found in large quantities along the western base of the Blue Ridge in Rockbridge County near Balcony Falls. It forms a bed that intervenes between the upper Primordial shales and sandstones, and seems to have had its origin in the disintegration of a friable sandstone that rests against the base of the mountain, and in some places has been exposed to view in mining for the iron-ores of this region. Prof. Rogers says: "This mineral has every quality suitable for the manufacture of glass." Exposures of it occur on the Dover and Brady properties on the North River branch, and on the Glenwood property on the James River branch of the railroad.

*Asbestus* is a fibrous mineral of soft and pliable texture, very infusible and a good non-conductor of heat. These qualities make it valuable for many purposes. Among these may be mentioned fire-proof roofing for buildings, wadding for the surroundings of iron safes, steam-boilers, etc. It has been mined to some extent in Amelia County, near the Appomattox River, and on a corresponding range it has been found in Powhatan and Goochland counties. There is more or less of it in all the counties bordering on the James between the Blue Ridge and Richmond, and the increasing demand for it makes it an object worthy of attention among the land-owners, where beds of metamorphic rocks are found. The best quality of it is in reality a fibrous form of hornblende, and is generally found associated with the masses of hornblendic rocks that abound in different parts of the Piedmont section of the State.

*Plumbago*, or *Graphite*, is another mineral peculiar to the regions of metamorphic rocks, and has been found in various places in the Piedmont region of Virginia, as in Fluvanna, Albemarle, Nelson, and other counties; but profitable developments have not been made. More careful and persevering explorations, however, may yet bring to light some valuable beds of this important mineral.

## CONCLUSIONS.

In a Report like this, necessarily limited to what is most important to be known by those interested in the line of transportation, and by capitalists who are seeking fields for safe and profitable investments, only the salient points could be brought under review. No effort has therefore been made to present an exhaustive discussion of the subject. The resources most intimately associated with the development of the iron interests have been made most prominent, as being of paramount importance to all parties concerned. Much more might be added, but enough has been said to establish several important conclusions.

(1) The *water-power* afforded by 1000 feet of fall in the James between Williamson and Tide at Richmond, and the 200 feet additional on North

River between Lexington and Balcony Falls—all so well distributed as to be utilized at a great number of points—affords a ready means of gaining motive power for machinery at a minimum cost.

(2) Convenient *sites* for furnaces and other manufacturing establishments favorably distributed, a fine agricultural valley all along the line, a healthful climate, extensive railway connections at both extremities and at intermediate points, will make it an easy task to utilize the wonderful resources and facilities above presented whenever capital and enterprise can be transplanted to this most attractive field.

(3) *Fuel* is within your reach without limit. The extensive forests that have been mentioned will yield vast supplies of charcoal. At present the C. & O. and in the future the extension of R. & A. will supply coal and coke from the Kanawha Valley and the Richmond coal-field, in quantities ample to meet all demands.

(4) Within convenient distance of the lines of railway are the *iron-ores* of five of the important geological formations of Virginia, practically inexhaustible in quantity, of almost every known variety, and adapted to the manufacture of iron suitable for all purposes, as has been fully demonstrated by actual experiments.

(5) Lying side by side with these ores are vast beds of *limestone*, the value of which has been fully established for fluxing, for the manufacture of lime of different kinds, or for building-stone of superior quality; and at the same time well situated for both quarrying and shipping. Copper and gold, granite and slate, with other minerals less conspicuous, all have their attractions, and insure good results from more extensive appliances for their developments and utilization.

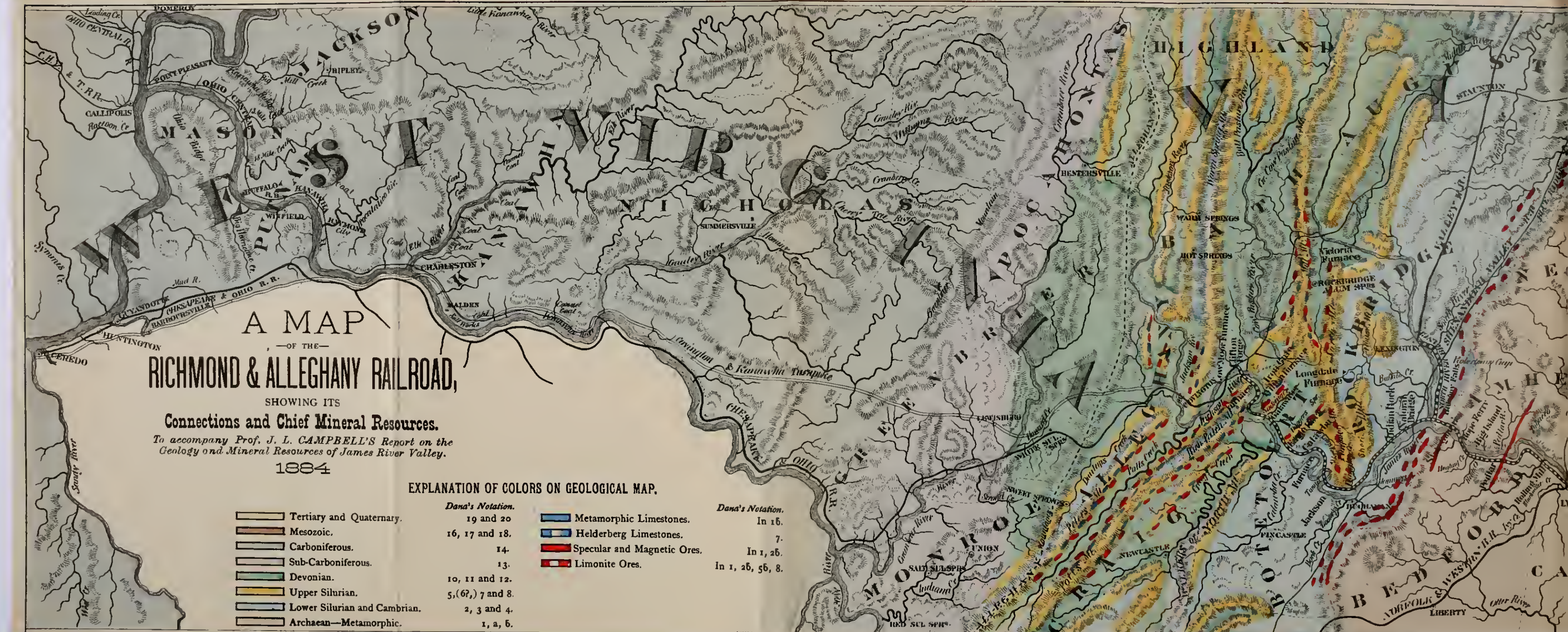
Such is "THE TESTIMONY OF THE ROCKS."

# GEOLOGY AND MINERAL RESOURCES OF THE JAMES RIVER VALLEY, VIRGINIA.

| NAMES OF STATIONS R. & A. R. R. | Miles from Richm'd. | MINERALS, ETC , MENTIONED IN GEOLOGICAL REPORT, AS FOUND NEAR THE SEVERAL STATIONS. |
|---|---|---|
| Richmond | 0 | Railroad Connections. See Report, p. 2 |
| Korah | 4. | Granite Quarry, p. 110 |
| Westham | 7. | Iron Works - Granite, south of river, pp. 109, 110 |
| Lorraine | 11.8 | Junction of Henrico Branch to Coal and Coke Mines, p. 94 |
| Boscobel | 18.6 | Dover Coal Mines, p. 93 |
| Dover | 20.1 | |
| Maiden's Adv | 30.3 | Mica, near Goochland C. H., p. 113 |
| Cedar Point | 32.7 | Fire Clay, in Powhatan Co., p. 114 |
| Irwin | 33.5 | |
| Rock Castle | 40.1 | |
| Stokes | 44.3 | |
| Pemberton | 46.6 | Cartersville, on opposite side of river. |
| Elk Hill | 51.6 | Magnetite and Steatite, pp. 19 and 113 |
| Columbia | 56.6 | Granite Quarry, p. 111; Gold Mines, p. 102 |
| Bremo Bluff | 66.4 | In Buckingham Co.—Iron, pp. 14 to 19; Granite, p. 112; Gold, pp. 102 to 106; Copper, p. 98; Slate, pp. 106 to 108 |
| Howardsville | 91 | Iron Ores, p. 35; Mesozoic Rocks, p. 35 |
| Warminster | 99.2 | Manganese Mine and Limestone, pp. 97, 84 |
| New Market | 108.6 | Iron Ore, p. 35; Copper, p. 99; Limestone. |
| Greenway | 114. | Iron Mines, pp. 28, 37; Limestone, p. 83 |
| Gladstone | 118.1 | Iron Ores and Limestone, pp. 28, 38 |
| Allen's Creek | 120.4 | " " " |
| Riverville | 123. | Iron Ores, pp. 40, 41 |
| Walker's Ford | 126.2 | Manganese, p. 30; Iron Ores, pp. 29, 30, 41, 42; Limestone, p. 83 |
| Stapleton | 130.8 | Iron Ore on both sides of river, p. 43; Limestone, p. 43 |
| Joshua Falls | 135.9 | Mt. Athos Mines, pp. 45, 50 |
| Lynchburg | 146.7 | Railroad Connections, p. 3; Building Stone, p. 112 |
| Pedlars | 159.4 | Iron Ores, p. 50 |
| Coleman's Falls | 160.8 | Iron Ores, p. 50 |
| Rope Ferry | 170.3 | Amherst Co.—Slate Quarry, p. 108 |
| Balcony Falls | 174.4 | Iron Ores, p. 52; Hydraulic Limestone, p. 85; White Sand, p. 116; Fire Clay, p. 114 |
| Natural Bridge, | 178. | Natural Curiosity, p. 5; Glenwood Iron Mines, pp. 54, 56 |
| Indian Rock | 188.3 | Corraline Limestone—Dillon's Kilns, pp. 86, 87 |
| Buchanan | 195.3 | Furnace Site, p. 96; Arcadia, Cloverdale and Purgatory Iron Properties, pp. 54, 60 |
| Jackson | 199.5 | Limestones, pp. 84, 85 |
| Saltpetre Cave | 205.2 | |
| Salisbury | 208.2 | Furnace, Ores, and Limestone, p. 61 |
| Eagle Rock | 212.5 | Iron Ores p. 61; Limestone, p. 87 |
| Gala Water | 216.6 | Daggers Springs, p. 66; Rebecca Furnace and Ores, pp. 69, 70 |
| Baldwin | 221. | Craig's Creek Ores, pp. 6, 63, 65; Ore and Limestone, p. 67 |
| Wilton | 223.4 | Ore and Mines, pp. 77, 78 |
| Iron Gate | 228.3 | Ores and Limestones, p. 75 |
| Clifton Forge | 230.3 | Connection with C. & O. Railway—Ores of Rich Patch Mts., p. 71, etc. |

## LEXINGTON BRANCH.

| | | |
|---|---|---|
| Balcony Falls | 174.4 | See above. |
| Loch Laird | 184.3 | Connection with S. V. Railroad, p. 5 |
| Green Forest | 186.6 | Buena Vista Iron Mines, p. 63 |
| Lexington | 195.6 | Connection with Valley Railroad, p. 3; Public Institutions, p. 5; Grey Marble and Limestones, p. 86 |



# A MAP

—OF THE—

# RICHMOND & ALLEGHANY RAILROAD,

SHOWING ITS

## Connections and Chief Mineral Resources.

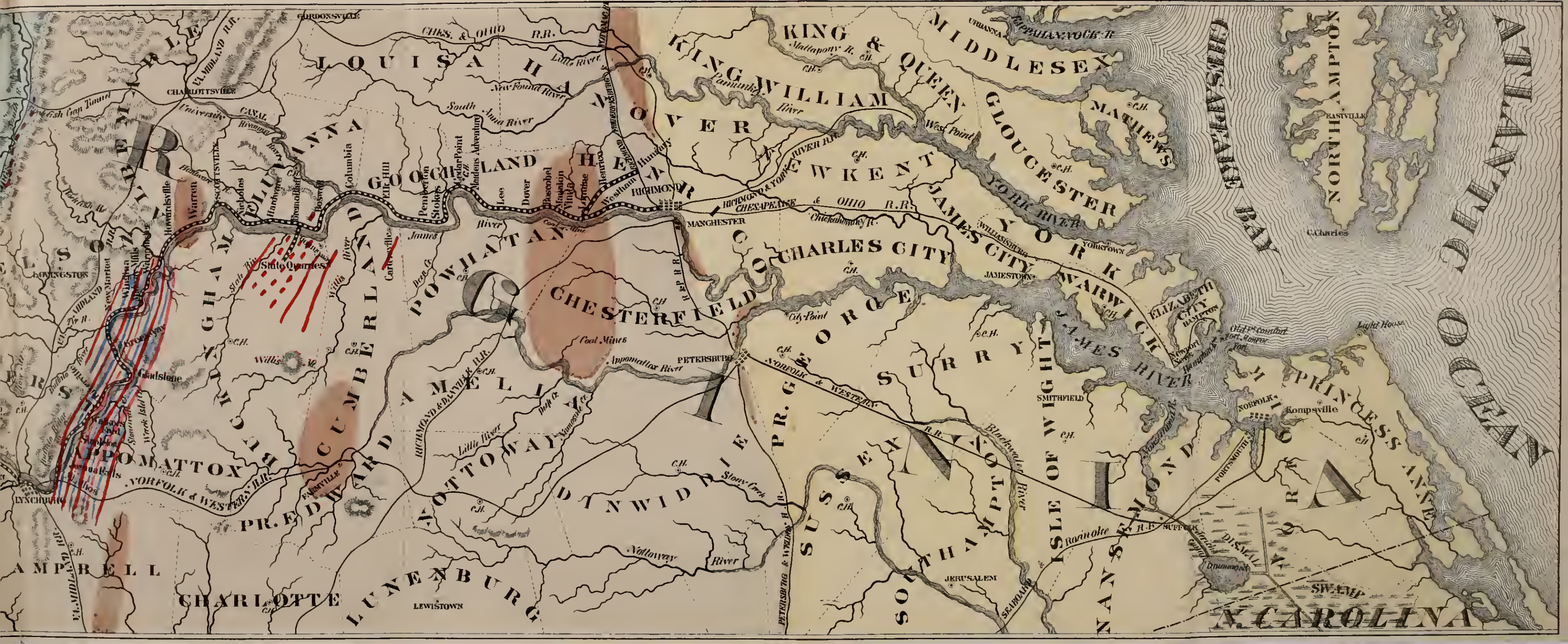
*To accompany Prof. J. L. CAMPBELL'S Report on the Geology and Mineral Resources of James River Valley.*

1884

### EXPLANATION OF COLORS ON GEOLOGICAL MAP.

| | | *Dana's Notation.* |
|---|---|---|
| ⬜ | Tertiary and Quaternary. | 19 and 20 |
| 🟫 | Mesozoic. | 16, 17 and 18. |
| ⬜ | Carboniferous. | 14. |
| ⬜ | Sub-Carboniferous. | 13. |
| 🟩 | Devonian. | 10, 11 and 12. |
| 🟨 | Upper Silurian. | 5,(6?,) 7 and 8. |
| ⬜ | Lower Silurian and Cambrian. | 2, 3 and 4. |
| ⬜ | Archaean—Metamorphic. | 1, a, b. |

| | | *Dana's Notation.* |
|---|---|---|
| 🟦 | Metamorphic Limestones. | In 1b. |
| 🟦 | Helderberg Limestones. | 7. |
| 🟥 | Specular and Magnetic Ores. | In 1, 2b. |
| 🟥 | Limonite Ores. | In 1, 2b, 5b, 8. |


ALBEMARLE
LOUISA
HANOVER
KING WILLIAM
KING & QUEEN
MIDDLESEX
MATHEWS
GLOUCESTER
NORTHAMPTON
CHESAPEAKE BAY
ATLANTIC OCEAN
GOOCHLAND
HENRICO
NEW KENT
YORK
JAMES CITY
CHARLES CITY
WARWICK
ELIZABETH CITY
FLUVANNA
BUCKINGHAM
CUMBERLAND
POWHATAN
CHESTERFIELD
AMELIA
PR. GEORGE
SURRY
ISLE OF WIGHT
NANSEMOND
NORFOLK
PRINCESS ANNE
APPOMATTOX
PR. EDWARD
NOTTOWAY
DINWIDDIE
SUSSEX
SOUTHAMPTON
LUNENBURG
CHARLOTTE
CAMPBELL
NELSON
VIRGINIA
N. CAROLINA
GORDONSVILLE
CHARLOTTESVILLE
University
Crozet Blue Ridge Tunnel
CHES. & OHIO R.R.
VA. MIDLAND R.R.
CANAL
RICHMOND
MANCHESTER
PETERSBURG
LYNCHBURG
LOVINGSTON
Gladstone
Warren
Howardsville
Scottsville
Columbia
Elk Hill
Cartersville
Maidens Adventure
Cedar Point
Pemberton
Stokes
Lee
Dover
Boscobel
Manakin
Vinita
Westham
Hungary
State Quarries
Willis Mt.
Coal Mines
Appomattox River
James River
Willis River
Little River
North Anna River
South Anna River
New Found River
Mattapony R.
Pamunkey River
West Point
York River
Rappahannock R.
URBANNA
EASTVILLE
C. Charles
Chickahominy R.
CHESAPEAKE & OHIO R.R.
RICHMOND & YORK RIVER R.R.
RICHMOND & DANVILLE R.R.
NORFOLK & WESTERN R.R.
PETERSBURG & WELDON R.R.
Seaboard & Roanoke R.R.
WILLIAMSBURG
YORKTOWN
JAMESTOWN
City Point
HAMPTON
Old Pt. Comfort
Fort Monroe
Newport News
Light House
SMITHFIELD
NORFOLK
PORTSMOUTH
Kempsville
SUFFOLK
Dismal Swamp
Blackwater River
Nottoway River
Stony Creek
JERUSALEM
FARMVILLE
LEWISTOWN
C.H.